



CHARTING COMMON GROUND FOR SALMON AND BUILDINGS

Prepared By:

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Disclaimers










While every effort has been made to thoroughly research the topics presented herein to ensure technical accuracy, the authors are not salmon biologists nor Seattle City staff. As such, any discrepancies relative to fact or policy-related issues should be considered errors. Please notify the authors of any errors that are found.

The City of Seattle, Seattle Public Utilities, and Seattle City Light, while co-funders of this research project, are not the authors of this report and recommendations, and take no responsibility for the data or recommendations contained herein.

For more information on the City of Seattle's Sustainable Building Program, see www.cityofseattle.net/sustainablebuilding.

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Executive Summary



Charting Common Ground for Salmon and Buildings was prepared as part of a sustained effort by the City of Seattle to reconcile the needs of the natural environment with those of the region's human inhabitants, with a specific focus on the interplay between salmon and people. While there is compelling evidence that building related industries, the construction process, and the operation and dismantling of buildings affect the environment in general, what is not so clear is the extent to which these dynamics affect salmon. Paralleling efforts focused on Salmon Friendly Gardening practices, as developed by Seattle Public Utilities, and the Salmon-Safe™ Farm Management Certification Program, as originally developed by The Pacific Rivers Council, Inc. and now under the auspices of Salmon-Safe Inc., this report explores how buildings fit into the salmon decline puzzle, and establishes a framework to identify buildings' direct and indirect contributions to this decline. Additionally, guidelines are offered that identify specific strategies to lessen the building-related burdens imposed on salmon and their habitat.

The report notes a disturbing long term trend: the decline of wild salmon in the Pacific Northwest. Indeed, the numbers are staggering: according to the most recently published sustainability indicators report for the Seattle region, local wild salmon runs declined by 50% to 75% from the mid-1980's until the early 1990's at which time they stabilized at dangerously low levels. And, while significant study has assessed the relationships between *where* buildings are located and salmon habitat decline, much less study has focused on the aggregate toll that buildings through their life cycle have on salmon and the waters in which they live. While the boundaries for this study are broad, this inquiry is narrowed to a few key building-related spheres of influence that represent either a high mitigation potential or for which little primary research has been undertaken:

- generic *site* issues (independent of building location)
- *upstream* material environmental burdens – the BaselineGreen™ analysis
- building *use* phase impacts
- *downstream* material environmental burdens

Reflecting the uncertainty inherent in assigning precise cause and effect relationships, we introduce the precautionary principle as a basis to establish association between particular actions and outcomes connected to decline, summarized in the following statement:

“Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”

The U.S. Green Building Council's LEED™ (Leadership in Energy and Environmental Design) green building rating system serves as the report's organizational framework, while the upstream environmental burden data associated with building materials is derived from BaselineGreen™ which identifies three impact categories (greenhouse gases, criteria air pollutants, and toxic releases) linked to the bill of materials for new single-



family residential, new office, and new retail construction in the tri-county region (Snohomish, King, and Pierce).

The principal conclusion of the BaselineGreen™ analysis is that the upstream impacts of building materials on salmon in the tri-county region, in *quantitative* terms, is relatively small, particularly when compared to impacts associated with other regional industries. Moreover, although the three BaselineGreen™ analyses indicated that, for average construction in the entire U.S., many building related materials and products are associated with upstream toxic releases, air pollution, and greenhouse gas emissions, *the data suggest that local and regional industries in Seattle and the State of Washington are “cleaner and greener” than the U.S. average.* State of Washington toxic release data from 1999 associated with building-related industries reveal relatively small documented toxic releases to water, no toxic releases to land, and toxic releases to air less than 5% of the statewide total. Therefore, specifying materials and products from local and/or regional manufacturers will not necessarily result in an increase in associated upstream environmental burdens at the local and regional scale, and may, in the case of Washington, *improve* the environmental performance as compared with national averages. With the exception of cement and fabricated steel products, the same can be said for Washington State’s upstream criteria air pollutant and greenhouse gas emissions.

For the five areas tracked by BaselineGreen™ — toxic releases to water, toxic releases to land, toxic releases to air, criteria air pollutants, greenhouse gas emissions – our findings are:

- **Toxic releases to water:**
Compared to other industries such as paper manufacturing, building related industrial toxic releases to water reported in 1999 were less than 1 percent. This is true for both the three county region and the rest of the State of Washington. These releases to water were made by three wood treatment facilities, one of which is located in the tri-county region.
- **Toxic releases to land:**
With the exception of waste disposal, building related industrial toxic releases to land reported in 1999 were zero. This is true for both the three county region and the rest of the State of Washington.
- **Toxic releases to air:**
Compared to other industries, building related industrial toxic releases to air in 1999 were relatively small. The percentage of statewide reported toxic releases to air that can be attributed to building related industries is less than 5% of the total.
- **Criteria air pollutants:**
With the exception of cement, building related industrial criteria air pollutant releases in 1999 were relatively small. The cement industry accounts for a significant share of all types of criteria air pollutant emissions in the three county region.
- **Greenhouse gas emissions:**
Emissions of CO₂ associated with the manufacture of cement and fabricated steel products account for a substantial portion of greenhouse gas emissions in the three county region and possibly a large portion of greenhouse gases in the rest of the State of Washington. Two cement plants and one lime facility in the tri-county region account for approximately 1.4 million tons of CO₂ emissions per year, while



the CO2 emissions total for the steel product manufacturer located in King County is about 250,000 tons per year.

However, the BaselineGreen™ findings may not tell the whole story due to possible weaknesses in the TRI data. These include the potential for industry misreporting of emissions, the provision for small quantity generators to avoid reporting requirements, and the potency associated with persistent bioaccumulative toxins (PBTs) as a class of chemicals, and other highly toxic chemicals, that may not be reflected in the way data are currently reported, nor account for the cumulative, long-term and synergistic effects of multiple chemical releases.

With the BaselineGreen™ analysis not revealing a substantial *direct* link to salmon decline, our study pursued five other possible building related activities as having a potentially greater impact on salmon habitats in the region:

- **Stormwater Runoff & Impervious Cover:**
The rule of thumb is that watershed health is threatened when impervious cover exceeds 10%. Since most of Seattle exceeds this level, we concur with Seattle's current aggressive stormwater management practices and strict contaminant control of runoff consistent with the State of Washington Department of Ecology's "Stormwater Management Manual for Western Washington".
- **Salmon-Friendly Hydro, Greenhouse Gas Emissions, & Ozone Depletion:**
The City of Seattle should be commended for its attention to the potential damaging affect of hydro facilities on salmon with the upgrading of its hydro facilities to ensure that there is no blockage of salmon passage, in addition to meeting the requirements of the Low Impact Hydropower Institute. While hydro does not contribute to greenhouse gas emissions, several building related industries in the tri-county region do, most notably the two cement kilns located on the Duwamish Waterway. Efforts to mitigate greenhouse gas emissions should be pursued, as should the substitution of alternative cements, such as fly ash, to reduce the net CO2 impact of concrete on salmon. The release of CFCs and HCFCs contributes to stratospheric ozone layer depletion, resulting in increased exposure to ultraviolet radiation, to which salmon have vulnerability. Our analysis found two manufacturers in the tri-county region using CFCs, despite their ban as of 1996. We recommend no allowance for continued use of CFCs, and an accelerated phase-out of all ozone depleting compounds as called for by the Montreal Protocol; at a minimum, compliance with the phase-out scheduled should be verified for all tri-county manufacturers.
- **Sand & Gravel Mining:**
Washington State is the nation's fifth largest source of aggregates; in the tri-county region alone, gravel mining operations cover over 9,000 acres. The extraction of sand and gravel disrupts habitat and contributes to erosion and sedimentation. We recommend specifying alternative aggregates for concrete mixes, and strict monitoring for all current sand and gravel operations. Policies for grandfathering of permitted facilities should be carefully reviewed to ensure that practices that could contribute to salmon decline are discontinued. Furthermore, with an estimated cost of \$50,000, we recommend the City of Seattle, in conjunction with other regional governments, consider pursuing the elements of a study proposed in the 1999 state legislative session (House Bill 1284) regarding sand, gravel, and rock



resource mining and its impact on salmon habitat and urban development, and identify environmentally sound sand, gravel and rock deposits. Current evaluations predict that existing mines will be unable to fulfill future demand for sand, gravel or rock.

- **Forest & Agrifiber Products:**

Forested lands produce both wood and salmon, with the extraction of wood and related forest practices contributing to loss of salmon habitat. Based on discussions with a certifier for the Forest Stewardship Council (FSC) regarding the accrued benefits associated with FSC certified products, the authors recommend specifying FSC-certified wood products and materials when they are cost-competitive and provide equal or superior performance than non-FSC certified wood products and materials. In addition to choosing products that ensure greater protection to salmon than non-FSC certified sources, this action will help to bolster market demand, and potentially catalyze an increase in FSC-certified forests, recognizing that less than 2% of Washington State's forested acreage is currently FSC certified. Furthermore, to reduce the burden on forests, the authors also recommend increased use of agrifiber products, such as wheat straw board, and support the establishment of wheat straw-based manufacturing businesses in the State of Washington, such as has been begun by the Washington Department of Community, Trade and Economic Development.

- **Toxic Chemicals:**

Toxic chemicals, particularly persistent bioaccumulative toxins (PBTs), pose significant threats to salmon as they accelerate the incidence of chemical effects, such as modification of DNA, and alter immune functions. In 2000 the U.S. EPA issued a general fish consumption advisory for the Puget Sound due to pollutant contamination, some of which were PBTs. Both the State of Washington and City of Seattle have policy initiatives that acknowledge PBTs' environmental health toll. PBTs with direct links to building materials are cadmium, dioxin, lead, and mercury. In July 2002, the Seattle City Council passed a resolution, introduced by City Councilwoman Heidi Wills, to reduce the purchase and use of persistent bioaccumulative toxics, instructing the City to forego the purchase of products that contain persistent chemicals, or that result in the release of persistent pollution during their manufacture. This resolution echoes our recommendation that the City of Seattle phase-out the use of PVC building materials, lead flashing and other lead roofing products as cost-competitive products of equal or better performance become available; specify paints that meet the Green Seal chemical requirements; prohibit cement kilns from burning fuels that release PBTs; and, work with state and regional agencies to ensure proper disposition of mercury containing light bulbs. As noted above, the only toxic releases to water were those emanating from three wood treatment facilities. Because of the broad risks to salmon, CCA (copper chromated arsenic), creosote and pentachlorophenol wood treatment chemicals should be banned in the tri-county region, with an accelerated phase-out of CCA enacted prior to the US EPA December 2003 sanctioned deadline. Seattle's Department of Parks and Recreation is commended for having prohibited the use of arsenate-treated wood products, and for encouraging the use of safer alternatives including reinforced recycled plastic wood.

Our findings also bring focus to the operational impacts of buildings. In the case of water, we note that Seattle Public Utilities' 1% for Conservation program has already yielded



strong results, with the utility accomplishing a 1% reduction per year since 1980. Similarly, Seattle City Light's commercial energy code is one of the nation's most stringent providing a solid demand side management plan curbing global warming contributions and the potential for habitat decline associated with hydroelectric facilities.

A related finding is that three of Seattle City Light's six largest electric customers are building-related industries: #1 is Birmingham Steel, with Ash Grove Cement #5 and Lafarge Cement #6. Steel and cement – the products of these factories – represent some of the largest volume and highest value materials used in residential and commercial building sectors. These three companies should be encouraged to continue to explore strategies to enhance operational efficiencies, such as have begun with established partnerships between the City of Seattle and Birmingham Steel, that will yield reduced electrical demand and a reduction in associated emissions.

Finding common ground for salmon and buildings is a work in progress, requiring deliberate alignment of design and construction practices and the methods and materials employed with the defining elements of ecosystem health. To the extent that the Pacific Northwest's salmon population serves as the region's yellow canary, ongoing monitoring and recalibration of best practices related to design and construction – where we build, how we build, what we build with – is vital.

Introduction



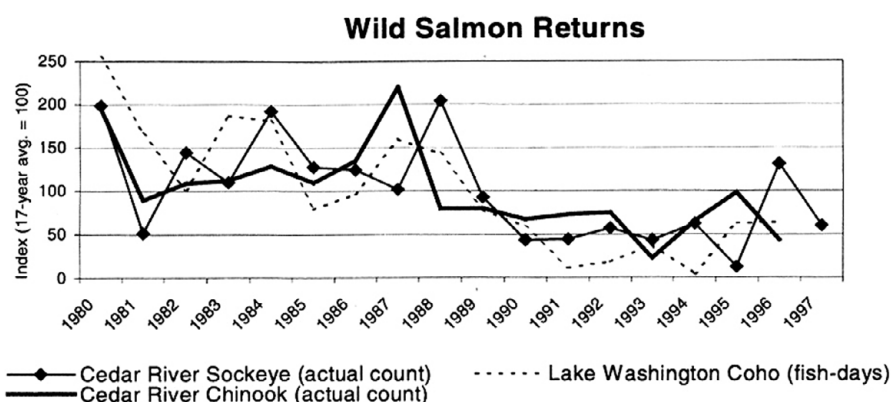
Motivation -- Salmon Decline

This study, commissioned by the City of Seattle with additional support from The Bullitt Foundation, responds to a disturbing long term trend: the decline of wild salmon in the Pacific Northwest. According to the most recently published sustainability indicators report for the Seattle region, local wild salmon runs declined by 50% to 75% from the mid 1980's until the early 1990's at which time they stabilized at dangerously low levels (see Figure 1).¹ The report notes the long-term downward trend as signifying a shift away from sustainability. As illustrated in Figure 2 on the following page, this century long decline has been documented for the Columbia River as well. It is no surprise that the people of Seattle chose wild salmon runs as a sustainability indicator, since salmon's ties to the region's cultural heritage, economy, tourism, recreation, and food production are well established, as is salmon's sensitivity to storm water run-off, drainage from lawns and farms, urban development, forestry practices, dams, and overfishing.

Reflecting the multiple uncertainties associated with specific cause-effect relationships contributing to salmon decline, saving salmon is complex. Indeed, in the last two decades, approximately \$3 billion has been spent on restoring salmon in the Pacific Northwest, yet their decline ensues. While seven salmon species are currently listed with the Endangered Species Act, more than 40 salmon and steelhead populations indigenous to Washington State have already become extinct.² In a report prepared by the Independent Scientific Review Group, habitat degradation in estuaries, rivers, and oceans was identified as the main cause of the decline in salmon stock, and restoring connected, viable habitats was considered achievable only by returning them to a "normative" state. The dimension of this concern is enormous, as watersheds with salmon and related endangered species cover 71% of Washington State.

As stated above, the enterprise of fixing the salmon problem is elusive, hindered by multiple challenges revealing the intricacies of salmon's ecological underpinnings as well as the uncertainty surrounding the cumulative effects of more than two centuries of increasingly intensive human development. Interestingly, these profound challenges are

Figure 1: Wild Salmon Returns in Washington State



Source: Seattle Sustainability Indicators Report (1998).



Salmon Decline

Washington Department of Ecology's Stormwater Management Manual for Western Washington

excerpt

The engineered stormwater conveyance, treatment, and detention systems advocated by this and other stormwater manuals can reduce the impacts of development to water quality and hydrology. But they cannot replicate the natural hydrologic functions of the natural watershed that existed before development, nor can they remove sufficient pollutants to replicate the water quality of pre-development conditions. Ecology understands that despite the application of appropriate practices and technologies identified in this manual, some degradation of urban and suburban receiving waters will continue, and some beneficial uses will continue to be impaired or lost due to new development. *This is because land development as practiced today, is incompatible with the achievement of sustainable ecosystems. Unless development methods are adopted that cause significantly less disruption of the hydrologic cycle, the cycle of new development followed by beneficial use impairments will continue.*³ (emphasis added)

Value of Salmon for Human Communities Stuart Cowan, EcoTrust's Conservation Economy Research Director

"... in a deeper sense, what is good for the salmon is good for human communities. If we are to create "salmon-friendly streets", urban habitats which are conducive to the health of salmon, we will almost certainly find that they are also conducive to human health. Salmon-friendly stormwater and wastewater treatment systems, patterns of resource use, building practices, and riparian buffers have multiple benefits. They may create recreational opportunities, help control flooding, reconnect us with natural cycles, save hard dollars in resource costs, and offer a wide-range of other environmental, social and economic benefits.... In effect, a salmon runs through the conservation economy, reminding us that whole-watershed, whole-systems approaches yield triple bottom line benefits."⁷

echoed with remarkable consistency from the grassroots to the state bureaucrats. This common voice reveals broad consensus that, short of a fundamental shift of western development practices, settlement patterns and burdens associated with continued population growth, reversing salmon decline is likely unachievable. (See sidebar)

In its report, *Upstream: Salmon and Society in the Pacific Northwest*, the National Research Council identifies continued population growth as a compounding factor, stating that efforts to save natural salmon runs by reducing per capita impacts through conservation measures, improved land use practices, improved dam passage, and better riparian protection, could be undermined by continued regional population and economic growth.⁴ Put in a regional context, between the 1990 and 2000 censuses, Washington State grew by more than 1 million people to 5,894,121, a 21 percent increase,⁵ with continued growth projected well into the 21st century. The population of the Seattle-Tacoma-Bremerton Metropolitan Area, currently at 3.5 million people, is projected to increase to 5.5 million by the year 2025.⁶ Thus, the potential to lessen burdens by adopting salmon-friendly practices may be negated by the sheer volume of construction activity associated with burgeoning population.

Further complicating the challenges associated with better-informed design and building practices is the legacy of more than a century of habitat disruption. Although not included in the scope of this report, remediation and restoration hold as much, if not more, importance for the resurgence of salmon than best practices applied to buildings in the pipeline today. That salmon still exist at all speaks more to their resilience than to the best-informed and intentioned contemporary design and construction methods and materials.

However, rather than forecasting failure, challenges such as have been raised point the compass in a clear direction: comprehensive and systemic transformation of the human footprint on the land. (see sidebar) Salmon are highly sensitive animals, and, as such, provide a barometer of ecosystem health. Moreover, salmon have intrinsic value as highly evolved species comprising their own unique aspect of the ecosphere. Thus the motivation for this study derives from both the *intrinsic* and *indicator* value of salmon.

Figure 2: Wild Salmon Returns to Columbia River



Source: www.nwd.usace.army.mil/ps/colrvbsn.htm

Objective and Scope – Buildings and Salmon

While significant research has assessed the relationships between *where* buildings are located and salmon habitat decline, there has been less focus on the aggregate toll that buildings through their life cycle – their materials of construction, the resources they consume to operate, the by-products they generate – have on salmon and the waters in which they live. Building on parallel efforts focused on Salmon Friendly Gardening practices, as developed by Seattle Public Utilities, and the Salmon-Safe™ Farm Management Certification Program, originally developed by The Pacific Rivers Council, Inc. and now under the auspices of Salmon-Safe Inc., Portland, Oregon, this report explores how buildings fit into the salmon decline puzzle, and establishes a framework to identify buildings' direct and indirect contributions to this decline. Additionally, guidelines are offered that identify specific strategies to lessen the building-related burdens imposed on salmon and their habitat. Illustrating the pivotal role that buildings play, a draft report released by the Northwest Fisheries Science Center found that the areas determined to be the “worst” locations for salmon stocks had less than 1% urban/built land cover, suggesting that stocks are sensitive to even minor variations in urban development.⁸ Indeed, a survey of life cycle building-related activities and dependencies reveals multiple breaches to the ecological integrity of the habitats of salmon and other species. Among these are increased impervious cover, alteration of water quantity and quality, transformation of fragile forest ecosystems, release of persistent bioaccumulative toxins, and extraction of finite mineral stocks.

Figure 3 illustrates the four distinct phases of a building's life cycle. Such a life cycle perspective is important to properly value the salmon-friendly strategies. Similarly, additional costs associated with suggested environmental mitigation strategies should be viewed in a life cycle cost context, as in many cases higher first-cost investments can offset anticipated economic burdens associated with conventional practices. Thus,

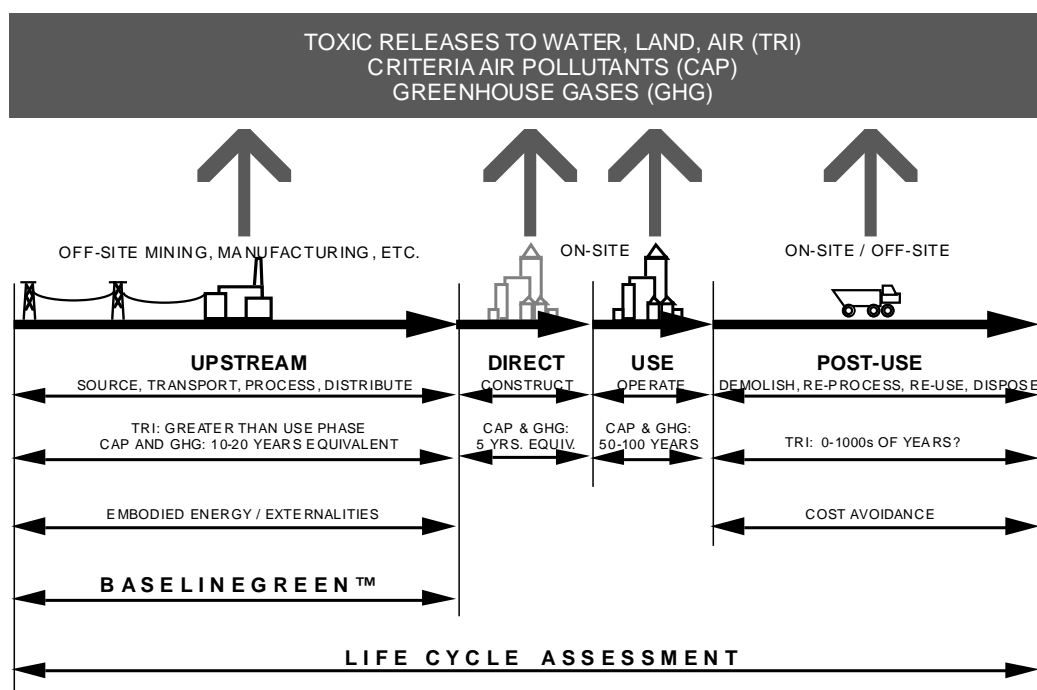


Figure 3: Relative Impact of Toxic Releases, Criteria Air Pollutants, and Greenhouse Gas Burdens Throughout an Entire Building Life Cycle

Toxic releases to water, land, and air, as well as air pollution and greenhouse gas emissions are associated with each stage of a building's life cycle. Upstream manufacturing of building materials and products typically accounts for a higher amount of toxic releases than other life cycle stages of a building. However, upstream manufacturing of building materials and products typically account for a much lesser amount of air pollution and greenhouse gas emissions than the use life cycle stages (occupancy) of a building. Typically, environmental burdens from energy consumption from fossil fuel generated sources and maintenance and repair activities outweigh upstream burdens. The post-use (downstream) stage of a building's life cycle may pose public health risks and environmental impacts if the materials and products used in the building contain hazardous substances (e.g., asbestos or lead). The BaselineGreen™ analysis examines the environmental burdens associated with the upstream life cycle stage. [Figure by the authors.]

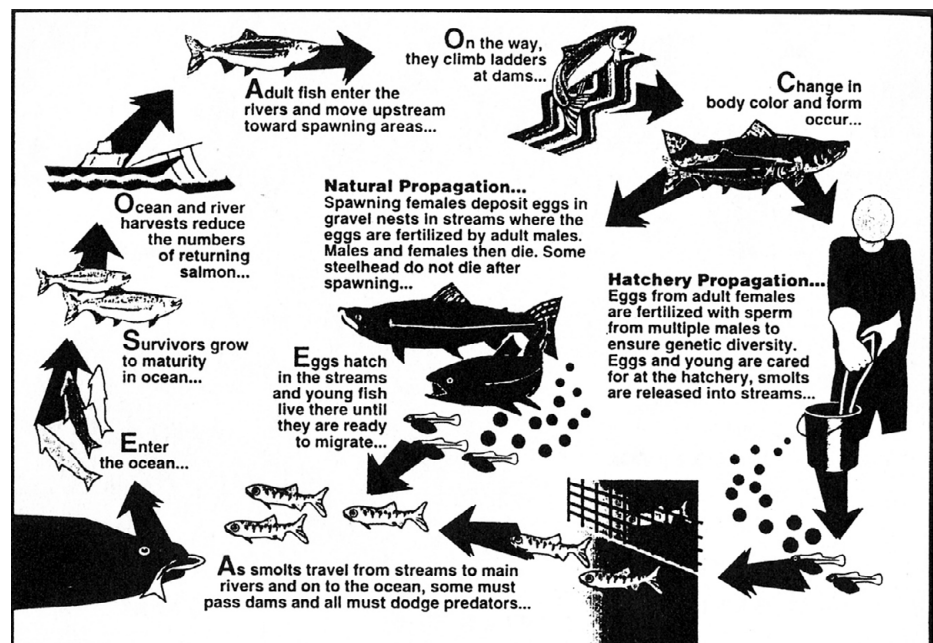
avoiding future costs resulting from water quality decline, deforestation, global warming and other micro- and macro-ecological transformative processes benefits economic as well as environmental interests. Such a full life cycle costing accounts for natural capital as well as financial and social capital.

While the boundaries for this study are broad, this inquiry is narrowed to a few key building-related spheres of influence that represent either a high mitigation potential or for which little primary research has been undertaken:

- generic *site* issues (independent of building location)
- *upstream* material environmental burdens
- building *use* phase impacts
- *downstream* material environmental burdens

To understand the geographic breadth of this study, it is helpful to review the life cycle of salmon. (See Figure 4) In the fall or spring females select sites for spawning in a stream bed, dig crater-shaped depressions in the gravel and deposit pea-sized eggs which can range in number from a few hundred to several thousand. Males then compete to fertilize the eggs, which females subsequently bury and guard. Within a few weeks adults of both genders die near the spawning sites. The eggs develop in the gravel and hatch several months later into larvae, known as alevins, which remain buried until consuming their yolk sac. They then emerge as free-swimming fry, which either begin feeding in the stream or migrate from it. Some species migrate to the sea directly, while others, such as coho, migrate after a year. Young salmon, which are adapted to freshwater, prepare for their new saltwater environment through a complex developmental transformation called smoltification, which involves physiological, biochemical, morphological, and behavioral

Figure 4: Salmon Life Cycle



Source: "Upstream: Salmon and Society in the Pacific Northwest," Committee on Protection and Management of Pacific Northwest Anadromous Salmonids; National Academy Press, Washington, D.C., 1996, p. 22.

changes.⁹ Most salmon reach maturity in the ocean and return to the site of their birth to spawn after 2 to 6 years, thus completing the cycle. Some species, such as Kokanee, never migrate to the sea, but reach maturity in freshwater lakes. Not all salmon die after spawning; cutthroat and steelhead migrate back to the sea after spawning, and then return to spawn again after one or more seasons.¹⁰

In part, the methodology interrelates the life cycles of salmon and buildings - the start of a systems-based approach. The complexity of the salmon issue calls for systems thinking as expressed in the following excerpt from an essay on aquatic biodiversity:

“There is little point in attempting to conserve particular species without paying attention first to the whole system....The problem that we have is that maintaining the aquatic system is more difficult than the maintenance of, say, a functioning area of forest or grassland as an island of diversity amid a sea of damaged landscape. It is not possible to draw a boundary around a freshwater system, as is frequently done around a patch of terrestrial habitat to preserve it, with reasonable success, at least in the medium term.”¹¹

In working with the two life cycles - salmon and buildings - we note that while the salmon life cycle is truly a cycle (since salmon can reproduce), the building life cycle generally exists as a linear flow - the loop hasn’t been closed. In a spatial sense, the life cycle of buildings, also expressed as the ecological footprint, may have an expansive geographic scope, since the raw materials for many building products can come from all over the planet. Similarly, because salmon move from freshwater streams confined to finite watersheds to the ocean, they are affected by a global flow of resources which complicates the ability to have precision relative to environmental stressors.

Although we acknowledge the footprints of salmon and buildings in global terms, the geographic boundary of this study focuses on the tri-county region - Snohomish, King, and Pierce counties - which corresponds to regional initiatives. The watershed, while different in scale than the *salmonshed* (which we define as fresh water, estuarine, and saline and therefore global) nevertheless is an effective scale for identifying the multiple life cycle building-related stressors: e.g., industrial emissions, total impervious cover, riparian canopy. (See map on following page)

It is fair to say that as with many analyses of salmon, this study lacks scientific certainty. However, we consider it both productive and beneficial to identify building-related strategies, materials, and methods that individually and collectively have the *potential* to enhance the co-existence of human habitat (our buildings) and salmon habitat. This approach is consistent with the Precautionary Principle, adopted at the 1992 United Nations Earth Summit in Rio de Janeiro. (See sidebar for more information on the Precautionary Principle.)

Finally, while the focus of this study is on buildings’ contribution to salmon decline, we acknowledge that considering buildings as isolated elements within an ecosystem provides only a slice of what is necessarily a multi-faceted, integrated approach to redefine human settlement patterns. By filling in some of the gaps, this report can contribute to

The Precautionary Principle
adopted at the 1992 United Nations Earth Summit in Rio de Janeiro

In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.¹²

Wingspread Statement on the Precautionary Principle
adopted by a diverse group of international scientists, environmental health advocates and academics

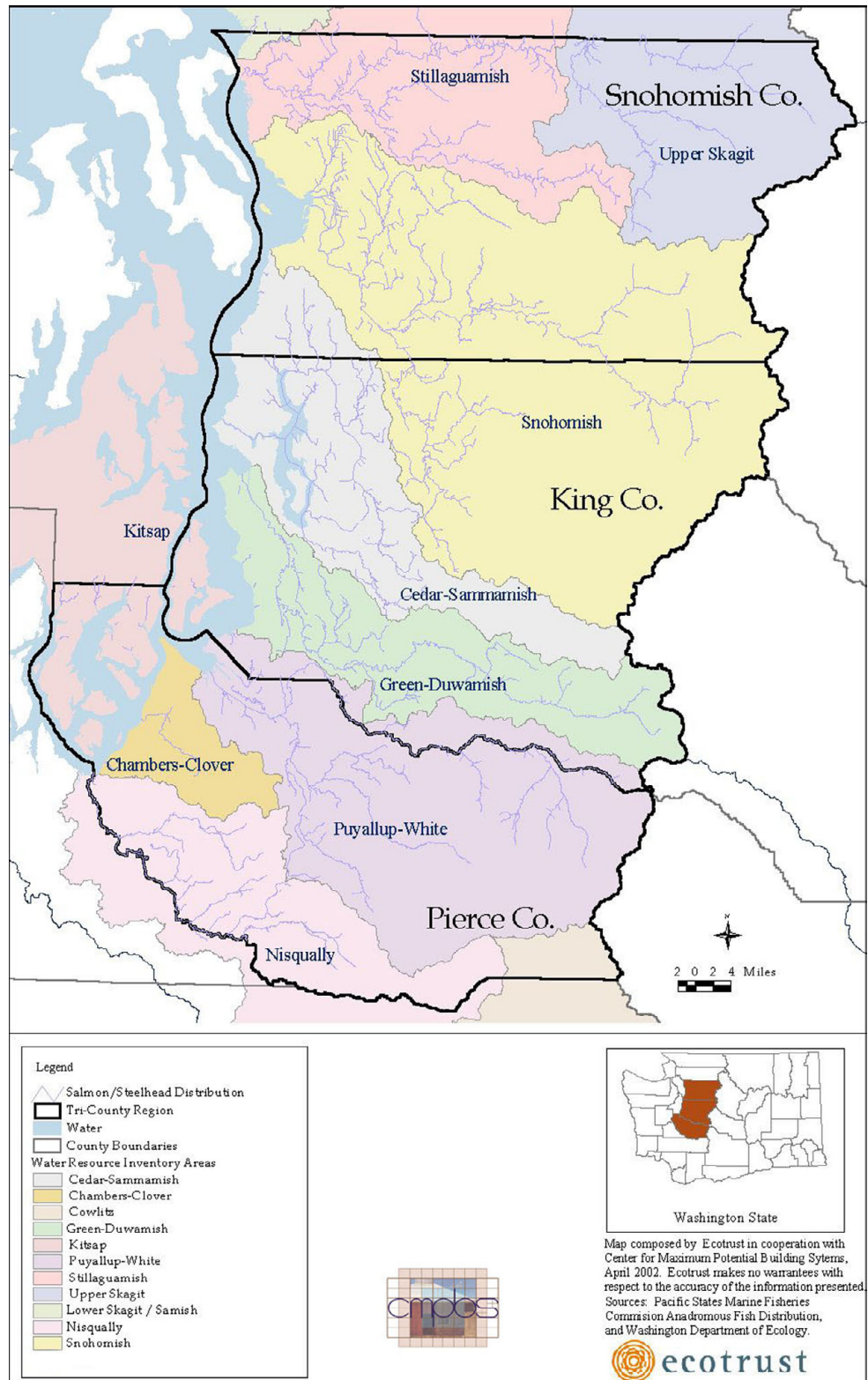
excerpt (full text Appendix B)

“...it is necessary to implement the Precautionary Principle: Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”¹³

Application of the Precautionary Principle
salmon strategy

Activities that may result in significant adverse effects on EFH (essential fish habitat) should be avoided where less environmentally harmful alternatives are available. ...Any ...activities (including construction/urbanization, forestry, irrigation water withdrawal, mineral mining, road building and maintenance, sand and gravel mining, wastewater/pollutant discharge, woody debris/structure removal from rivers and estuaries) may eliminate, diminish, or disrupt the functions of salmonid EFH.¹⁴

Figure 5: Salmon/Steelhead Habitat in the Tri-County Region



that process. However, as much as we draw attention to salmon, we recognize that the health of salmon and their habitats are indicators of the broader objective of the ecological wellbeing of the planet.

Organization of this Report

Methodology -- LEED™

Because LEED™¹⁵ is increasingly serving as the common and defining language for green building, the LEED™ 2.0 categories – *Sustainable Sites*, *Water Efficiency*, *Energy & Atmosphere*, *Materials & Resources*, *Indoor Environmental Quality*, *Innovation & Design Process* – are used as the organizational framework to facilitate integration into existing City of Seattle programs. Thus the report contains a section for each of these six categories, including salmon impacts and salmon-sensitive amended language for existing credits. This builds on Seattle’s approach to LEED™ to date, which requires LEED™ Silver certification for all new construction and major renovation projects of 5,000 square feet and greater, and customizes LEED™ to reflect the City’s priority concerns and heighten its local relevance.

Within this framework several analyses were undertaken to bring focus to the specific ways that buildings, through their life cycle, affect salmon and their habitat. The area representing the most in-depth study, *Materials and Resources*, was evaluated in part using BaselineGreen™, and five other priority considerations beyond its scope:

- Impervious cover / stormwater runoff (*Sustainable Sites*)
- Salmon-friendly Hydropower, Greenhouse Gas Emissions & Ozone Depleting Compounds (*Energy and Atmosphere*)
- Sand & Gravel mining (*Materials and Resources*)
- Forest & Agrifiber Products (*Materials and Resources*)
- Toxic Chemicals (*Materials and Resources*, *Indoor Environmental Quality*)

BaselineGreen™ – Summary of method

Since approximately half of the effort expended on this study was dedicated to the BaselineGreen™ analysis, it deserves further introduction. Environmental Life Cycle Assessment (LCA) is an approach to the systematic and quantitative study of the upstream, use, and downstream environmental implications of products. Life Cycle Assessments can be conducted using either process-level modeling, or industry/commodity level Input/Output modeling. BaselineGreen™ utilizes the latter approach and limits its scope to only the upstream (or “embodied”) environmental consequences of the full set of hundreds of inputs required for a building project. The project input set is fully comprehensive and includes inputs of raw materials, energy, equipment, fabricated products, intermediate products, and services.

By “upstream”, we mean all those processes whose outputs are used directly or indirectly to support an activity of interest. Another word for an activity’s family of upstream processes is its “supply chain.” Theoretically the chain of suppliers is infinite, since all suppliers in turn have their own suppliers. However, we have found from empirical experience that after approximately six to eight supply tiers, the share of total upstream productive output added by additional tiers becomes negligible. This result is in turn caused by the fact that, by definition, the total value of the inputs to an economically

viable production process must be less than the value of its output.

The BaselineGreen™ analysis is designed to identify in hierarchical fashion the specific building materials likely to be the largest contributors to salmon and habitat decline relative to extraction and manufacturing processes, and makes extensive use of detailed U.S. Input/Output data from the Bureau of Economic Analysis (BEA) together with federal data on pollution releases by sector from the U.S. Environmental Protection Agency (U.S. EPA) and federal data on fuel-specific energy consumption by sector from the U.S. Department of Energy's Energy Information Administration (EIA). We retained 498 industries from the BEA tables, including government enterprises such as the US Postal Service, and the 488 BEA commodities produced by these industries. For most manufacturing industries, the BEA industries and commodities match the U.S. four-digit Standard Industrial Classifications (SIC), now under the auspices of the North American Industrial Classification System (NAICS). Outside the manufacturing realm, some BEA industries represent aggregations of 4-digit SICs, while other BEA industries are composed of portions of one or more 4-digit SICs.

*One of the most significant findings of the BaselineGreen™ study is that the upstream impacts of building materials on salmon in the tri-county region, in quantitative terms, is relatively small, especially as compared to impacts associated with other regional industries. The U.S. EPA Toxic Release Inventory (TRI) data reveal no reported toxic releases to land, and relatively small quantity toxic releases to water, the industrial emissions considered to most directly effect salmon. Building-related toxic releases to air were reported, though these represent only 5% of TRI emissions to air of all reporting industries in the tri-county region. While emissions to air may be considered less direct than emissions to land or water, there is concern associated with the atmospheric deposition of air pollutants to land and water, as well as greenhouse gas emissions' contribution to global warming, and ozone-depleting compounds' contribution to stratospheric ozone depletion. In the latter examples, these global-scale outcomes have been found to lead to diminished quality of life for salmon. (See the following section and the *Materials & Resources* section for more details.)*

However, as is elaborated in the *Materials & Resources* section, the BaselineGreen™ findings may not tell the whole story. This relates to weaknesses in the TRI data, including the potential for industry under-reporting of emissions, the potential for small quantity generators to be exempted from reporting requirements, and the cumulative, long-term and synergistic effects of multiple chemical releases. What the BaselineGreen™ analysis does well is provide proportional representation of the continuing biochemical environmental stressors to salmon habitat resulting from the upstream impacts linked to the bill of materials associated with generic building design and construction practices, and provides a baseline reflecting national averages. In this way, we are able to compare the performance of regional industries to national industries.

Human-Induced Environmental Burdens

Human-induced environmental (i.e., non-predator/competitor and non-natural event) factors contributing to habitat loss and degradation in all types of habitat– freshwater, estuary, and saline water – can be sorted into two broad categories: water quality and water quantity/rate of flow. The major environmental factors in each of these two categories are summarized in Table 1.

Table 1: Summary of Environmental Factors Contributing to Salmon Habitat Loss and Degradation

Water Quality	Water Quantity/Flow
Toxic releases and sediment contamination	Too much water (stormwater runoff)
Erosion, sedimentation, and turbidity	Too little water
Water temperature fluctuations	Barriers, channels, and diversions

Source: "Factors Affecting Chinook Populations, Background Report" prepared for the City of Seattle by Parametrix Inc., Natural Resources Consultants, Inc., and Cedar River Associates, June 2000.

However, the scope of the BaselineGreen™ analysis is limited, as it now only functions as a partial life cycle tool, lacking some upstream life cycle criteria and certain site-based activities such as erosion.¹⁶ As such, the BaselineGreen™ assessment is narrower than the diverse origins of the many environmental factors discussed above.

As stated above, BaselineGreen™ examines three upstream environmental burdens associated with these inputs – criteria air pollutants¹⁷, greenhouse gases, and toxic releases - using national and state data for industrial facilities (point sources) that annually report these emissions. In its current status, these data are used to portray the typical toxic release inventory and air pollution history of several different industry groups. For this study, we correlated these data to the bill of materials for new retail, office and residential construction sectors, evaluated on four scales: office building (Seattle Justice Center), tri-county region, rest-of-Washington, and rest-of-US.

Toxic releases to water have a direct and significant impact on water quality. Toxic releases to land (or in underground storage) can seep into ground water sources and aquifers and eventually enter lakes, rivers, and streams. Toxic releases to air and criteria air pollutants can return to land and bodies of water through the process of atmospheric deposition. Greenhouse gas emissions can contribute to global warming and subsequently contribute to increases in water temperature and perhaps water level fluctuations.

Erosion, sediment deposition, and turbidity can be a result of logging and quarrying activities. The BaselineGreen™ analysis, as we have stated, does not attempt to examine these links without more development of the model. Additionally, urban development modifications to shorelines, rivers and streams – impervious cover, barriers, channels and dams – are beyond the scope of this work.

Tables 2 and 3 indicate the scale of origin of environmental factors affecting *water quality* and *water quantity*, respectively. The shaded cells indicate the BaselineGreen™ scope of work relative to all of the environmental factors described above: the environmental burdens that originate upstream from manufacturing inputs to buildings. These manufacturing inputs are usually industry groups that can be broken down into identifiable “point source” industrial facilities. In Table 3, note that BaselineGreen™ does not address any environmental factors affecting *water quantity*.

In each of the two tables a check indicates an environmental impact to salmon habitat and the scale at which the impact typically originates. Some are more local impacts such as point source toxic releases to water, some are more state and national in scale such as logging, and some are both such as air pollutants. Toxic releases, air pollutants, and greenhouse gases become urban, regional, and even statewide problems when automobile and truck modes of transportation of goods and services are included. Land use and land cover changes, as well as logging and mining activities, can become national and even international in scale when the watersheds in which the activities are located cross state and national political boundaries (e.g., Washington and British Columbia).

Within the BaselineGreen™ scope, the upstream building-related environmental burdens linked to the above factors are prioritized from most direct to least direct impact on salmon

habitat as follows:

- Most direct: Toxic releases to water,
- Toxic releases to land/underground,
- Toxic releases to air,
- Criteria air pollutants,
- Least direct: Greenhouse gases.

As mentioned above, the direct link between toxic releases to water or land and water quality is self-evident. Toxic releases to air and criteria air pollutants are less direct factors since the process of atmospheric deposition must occur to accrue airborne toxics and pollutants on land or in bodies of water. Atmospheric deposition also disperses and dilutes toxics and pollutants over a widespread area. Most of the State of Washington is rated as having low to moderate susceptibility to the process; in fact, documented levels of many

Table 2: Building and Urban Development Associated Environmental Burdens Detrimental to Water Quality Sorted by Origin
(Shaded cells indicate scope of work of the BaselineGreen™ analysis.)

Water Quality (Freshwater, Estuary, and Saline Habitats)	Environmental Factor	Building and Development Related Issue	Industrial Facility/ Industry Group	Urban Scale	Watershed / Regional Scale	State Scale	National Scale	International Scale
	Toxic Release Contamination	Toxic releases to water	✓	✓	✓			
		Toxic releases to land/underground	✓	✓	✓			
		Toxic releases to air	✓	✓	✓			
		Air pollutants	✓	✓	✓			
	Water Temperature Changes	Greenhouse gases	✓	✓	✓			
		Impervious cover		✓	✓			
		Land use and land cover changes		✓	✓	✓	✓	✓
	Erosion, Sedimentation and Turbidity	Impervious cover		✓	✓			
		Land use and land cover changes		✓	✓	✓	✓	✓
		Logging and mining			✓	✓	✓	✓

Table 3: Building and Urban Development Associated Environmental Burdens Detrimental to Water Quantity Sorted by Origin
(None of these building and development issues is included in the BaselineGreen™ analysis.)

Water Quantity and Flow (Primarily Freshwater and Estuary Habitats)	Environmental Factor	Building and Development Related Issue	Industrial Facility/ Industry Group	Urban Scale	Watershed / Regional Scale	State Scale	National Scale	International Scale
	Too Much Water	Impervious Cover		✓	✓			
		Dredging, Filling Channelization		✓	✓			
		Land Use/Land Cover Changes		✓	✓	✓	✓	✓
		Logging And Mining			✓	✓	✓	✓
		Channels and dams	✓	✓	✓			
	Too Little Water	Municipal, Industrial, Agricultural Use	✓	✓	✓			
		Lack of retention	✓	✓	✓			
	Barriers and Diversions	Land Use/Land Cover Changes		✓	✓	✓	✓	✓
		Dams	✓	✓	✓			

pollutant indicators have not increased over the past 20 to 30 years.¹⁸ Greenhouse gases are considered the least direct environmental factor since many steps and processes leading to increases in water temperatures are involved. Moreover, many other factors contribute to climate changes related to increasing air and water temperatures such as non-point source pollution (automobiles), urban heat islands, and vegetative cover. For example, non-riparian forest removal may have more impact on stream temperatures than the narrow bank of riparian areas.

Beyond the BaselineGreen™ scope, other urban and regional scale building and development activities are linked to the environmental factors contributing to salmon habitat loss and degradation. These include the following:

- Transportation issues (*Sustainable Sites*)
- Land use and land cover changes (*Sustainable Sites*)
- Changes to and loss of wetlands (*Sustainable Sites*)
- Percent impervious cover (*Sustainable Sites*)
- Municipal, industrial, and agricultural water use (*Water Efficiency*)
- Diversions and dams (*Energy and Atmosphere*)
- Logging and quarrying activities (*Materials and Resources*)
- Dredging, filling, and channelization of rivers and streams (*Materials and Resources*)

The first four of these issues are addressed by LEED™, while the remaining issues are addressed, at least in part, within this report.

Recommended Strategies

Beyond BaselineGreen™ findings, the building-related strategies that emerge as most beneficial to salmon are:

- Identify opportunities to reduce impervious cover/stormwater runoff (*Sustainable Sites*)
- Continue adherence to salmon-friendly hydropower, reduce greenhouse gas emissions associated with manufacture of portland cement and steel, and phase-out the use of ozone depleting compounds as cost-competitive alternatives become available (*Energy and Atmosphere*)
- Comply with and monitor NMFS best management practices for all regional sand and gravel extraction and substitution of recycled content/by-product aggregates for virgin stock (*Materials and Resources*)
- Bolster market demand for Forest Stewardship Council (FSC) certified wood products and materials and agrifiber substitutes by specifying them in applications for which they are cost-competitive and provide equal or better performance than non-FSC certified wood products and materials (*Materials and Resources*)
- Consistent with the Seattle City Council's passage of a resolution to reduce the purchase of toxic products on 1 July 2002, phase-out procurement of products that release toxic chemicals through their life cycle, particularly those that are persistent and bioaccumulative, as cost-competitive products of equal or better performance become available (*Materials and Resources, Indoor Environmental Quality*)



LEED™ Based Analysis

SS	WE	EA	MR	IEQ	ID
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The following sections adapt the established LEED™ 2.0 categories to a salmon-focused analysis, with suggestions for revised language, and technical and regulatory information that may have specific bearing on salmon. The primary salmon impacts for each LEED™ category are noted at the beginning of each section, followed by a credit by credit discussion of salmon-friendly recommendations and potential solutions, which are summarized in the Salmon-Friendly LEED™ Overlay (Appendix B). The authors assume LEED™ fluency among readers of this report. For background information, visit the U. S. Green Building Council web site.¹⁹

While the scope of this report excludes addressing where buildings locate, how buildings are designed and constructed directly affects site issues such as erosion and sedimentation control, impervious cover, and stormwater runoff, each of which relate to stormwater management. Since stormwater affects both water quantity and quality, responsible stormwater management is an essential element for safeguarding salmon habitat with a magnitude likely greater than for any other single category relative to near-term consequences. Sedimentation, pollution, and temperature fluctuations affect water quality, while the amount of total impervious cover area has a large effect on both water quantity and quality. Although many other features of the built environment influence urban stormwater runoff, such as roads and parking lots, buildings and their sites are significant factors.

Impacts to Salmon

The effects of erosion and sedimentation, pollution, temperature fluctuations, and total impervious area have the greatest impacts to salmon.

Erosion & Sedimentation

Soil erosion during construction is a potentially significant source of sedimentation in urban streams. Salmon, steelhead and coastal cutthroat trout are susceptible to sediment pollution because they build their nests in the stream bottom. The eggs, buried one to three feet deep in the gravel redd, rely on a steady flow of clean, cold water to deliver oxygen and remove waste products. During the 60 day period when eggs and alevin are in the gravel, major shifts of the stream bottom can kill them.²⁰ As the alevin develop into fry,

they use up their yolk and must emerge through spaces in the gravel to take up life in the stream. In a literature review, researchers found that increasing levels of fine sediment caused a decrease in salmonid egg and alevin survival. Fines less than 0.85 mm show the highest impact on egg survival but sand sized particles (<6.4mm) may also intrude into the stream bed forming a layer in the stream gravels which sometimes prevents emergence of fry.²¹ It has been postulated that because of varying head diameters, chinook salmon are the most susceptible to increased fine sediment, followed by coho salmon, steelhead and cutthroat trout, respectively.²²

Toxic Pollution

Urban stormwater can carry a range of pollutants including suspended solids, organic materials, hydrocarbons, heavy metals, insecticides, and herbicides (see Table 4). Although not all of these are toxic, urban stormwater runoff is one of the most significant sources of toxic water pollution.²³ Because buildings and associated infrastructure represent a significant percent of total impervious area in an urban environment, they are a source of some of these pollutants.

For example:

- Nutrients such as phosphorous and nitrogen can come from lawn fertilizer runoff, pet excrement, and failed septic systems, which are also a source of bacteria. In a process known as eutrophication, excess nutrients in surface waters promote algae growth which depletes oxygen by shading underwater plants;²⁴
- Hydrocarbons come from engine oil, gasoline, and diesel fuel which drip from vehicles onto roadways and parking lots;

Table 4: Typical Pollutant Concentrations in Urban Stormwater²⁸

Pollutant	Concentration*
Total Suspended Solids	80 mg/l
Total Phosphorous	0.3 mg/l
Total Nitrogen	2.0 mg/l
Total Organic Carbon	12.7 mg/l
Fecal Coliform Bacteria	3600 MPN/ 100 ml [^]
E. Coli Bacteria	1450 MPN/ 100 ml
Petroleum Hydrocarbons	3.5 mg/l
Cadmium	2 mg/l
Copper	10 mg/l
Lead	18 mg/l
Zinc	140 mg/l
Insecticides	0.1 to 2.0 mg/l
Herbicides	1 to 5 mg/l
Chlorides (winter only)	

*Results compiled from seven studies carried out between 1983 and 1997 by the Center for Watershed Protection for the *Maryland Department of Environment Stormwater Manual*.

[^] Bacteria levels measured in "Most Probable Number."

Table 5: Characterization of Stormwater Pollutants²⁸

Pollutant	Description
Suspended Solids	Soil particles and other material blown in from surrounding land, washed in by erosion, or dropped from vehicles. Suspended solids lead to sedimentation which is a direct threat to salmon.
Nutrients	Primarily nitrogen and phosphorous. Sources include fertilizer runoff from lawns, pet excrement, and failed septic systems.
Organic Carbon	Also referred to as biochemical oxygen demand (BOD), organic matter washed into surface waters decomposes through bacterial action, robbing the water of oxygen.
Bacteria	High levels of bacteria, including fecal coliform, are regularly found in stormwater. This is the health threat that most commonly closes public swimming areas and shellfish beds.
Hydrocarbons	A wide range of hydrocarbons, including engine oil, gasoline, and diesel fuel, are dripped onto roadways and parking lots. Many of these are toxic to aquatic organisms.
Trace Metals	Trace metals, such as lead, zinc, cadmium, copper, and mercury, are deposited into impervious surfaces from the atmosphere or from automobile tires and fluids. Cadmium and mercury are PBT's and copper is highly toxic to many aquatic organisms.
Pesticides	Pesticide residues remain a serious pollutant in stormwater and are often toxic to aquatic organisms.
Chlorides	Calcium chloride is routinely applied to cold-climate roads in winter for ice control and to dirt roads in summer for dust control.
Trash and Debris	While primarily a visual pollutant, trash is often contaminated with other pollutants.
Thermal Pollution	Asphalt pavements and low slope roofs heat up in the sun, and runoff from these surfaces can warm nearby streams threatening salmon habitat.

Salmon and Buildings

- Heavy metals come from vehicles' tires, fluids, and brake linings (in the case of copper);
- Pesticides and chemicals can contaminate runoff from landscapes;
- Asphalt pavements and low slope roofs heat up in the sun, and runoff from these surfaces can warm nearby streams threatening salmon habitat.

Earlier studies by and for the City of Seattle have indicated the presence of hundreds of chemical compounds from streets, highways, and other developed urban areas in stormwater. Several non-point sources were identified including automobiles, leaking septic fields, and household fertilizer use.²⁵

Water Temperature

As referenced in Table 5, asphalt pavement and low-slope roofs heat up in the sun, and runoff from these surfaces can warm nearby waterways. As with most tributaries in Seattle's urban and urbanizing regions, the Duwamish Estuary has experienced increased surface water temperatures over the past 20 years. Studies have associated this with factors resulting from urbanization, including increased runoff from impervious surfaces and loss of riparian vegetation.²⁶ Loss of watershed forest also increases watershed temperatures and may even exceed the impact associated with the loss of riparian shade, as the excerpt from a 1999 report reveals:

"Temperature models show that stream temperatures are more sensitive to air temperature than to shading (Sullivan et al. 1990). The US Fish and Wildlife Service SSTEMP model (Theurer et al. 1984), for example, predicts a 4°C increase in stream temperature for a 4°C air temperature increase (from 19°C to 23°C), while a change in canopy cover from 75% to 0% would cause a 5°C increase (Sullivan et al. 1990). Field measurements by Sullivan et

al. (1990) also suggest that air temperature has a stronger proportional influence on stream temperature than does shade.

"Effects of a cut margin on air temperatures in the adjacent stand are well described. Chen et al. (1995), for example, found at sites in western Washington and Oregon that maximum air temperatures at stand margins are elevated 2°C to 16°C relative to interior temperatures, and that the temperature effect generally extends 60 to 120 meters (equivalent to 1 to 2 tree heights) into the old-growth stand. A figure accompanying the paper (Chen et al. 1995, Fig.3) indicates that air temperatures 50 feet from the stand margin have recovered by only about 20%, and that recovery at 100 feet is on the order of 50%. Measurements by Sullivan et al. (1990) also indicate that temperatures at the margins of clearcuts are a minimum of 15% higher (relative to 0°C) than at locations more characteristic of the interior of a stand (Sullivan et al. 1990; the widths of the buffer strips are not noted). These results demonstrate the importance of managing riparian stands to maintain appropriate air temperature regimes if appropriate stream temperature regimes are to be maintained."²⁷

The Duwamish provides habitat for salmon during many life cycle stages, including adult migration, juvenile migration and rearing, and as a transition zone for adults and juveniles. Chinook, coho salmon and steelhead and cutthroat trout all require cold water. Although water temperature tolerance varies somewhat between species and between life stages, warm water temperatures can reduce fecundity, decrease egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, and decrease the ability of young salmon and trout to compete with other species for food and to avoid predation. The National Marine Fisheries System characterized salmonid habitat as "at risk" when

spawning temperatures exceed 15.5°C and rearing temperatures exceed 17.8°C. As a general condition, it has been recommended that floating weekly maximum water temperatures not exceed 15°C or that maximum temperatures not exceed 20°C in Washington State.²⁹

Impervious Cover

Since impervious cover area, also referred to as total impervious area (TIA), affects both stormwater quantity and quality, it is a direct determinant of watershed health. Urban areas are more likely to degrade streams than any other type of land use, including agriculture, forestry or range, and result in polluted runoff and altered hydrology,³⁰ reflecting the high concentration of impervious surfaces including building rooftops, sidewalks, parking lots, roads, gutters, storm drains, and drainage ditches in urban areas. The percentage of total impervious area can lead to starvation of shallow aquifers that provide the base for summer flows (which naturally limit salmon productivity) and, because impervious surfaces increase the amount of evaporation as compared to pervious surfaces, more runoff is produced exacerbating flooding in winter and robbing shallow aquifers that provide baseflow in summers.

In a study of 22 Puget Sound streams, researchers determined total impervious area to be the key index for gauging impacts on urban streams.³¹ The first signs of degradation come at about 5% TIA with very little ecological function retained in streams with more than 45% TIA.³² More specifically, coho populations appeared to be reduced in areas with 10-15% imperviousness. In general, deterioration of instream functions and value begin to occur when impervious surfaces exceed 10% of a subbasin.³³ Streams where setbacks allowed for protected riparian zones benefited from riparian function, such as filtering runoff and providing large woody debris (LWD). In urban streams, researchers found increa-

sed chemical runoff, increased flood peaks, loss of LWD and overall stream habitat complexity, increased fine sediment, and decreased diversity and abundance of aquatic insects and other biota.

Dense urbanization can also lead to flooding. Stormwater that runs off from multiple impervious surfaces into receiving streams leads to increased peak discharges, decreased discharge time for runoff to reach the stream, and increased frequency and severity of flooding. Of each of these outcomes, flooding is of particular concern as it reduces refuge space for fish and can scour eggs and young from the gravel.³⁴ Studies in King County compared hydrologic conditions between forested watersheds vs. fully urbanized watersheds (assuming 40% impervious surface) relative to flooding. Over a 40 year period, forested watersheds were predicted to have seven 5-year flood events with intervals ranging between four and 14 years, while urban watersheds were predicted to have 38 flood events with only a single year without a flood of this magnitude.³⁵ Roads and paved surfaces in urban areas have been found to effectively double the frequency of hydrologic events capable of mobilizing stream substrates. The resulting increased scour of gravel and cobble in places where salmon eggs, alevins, or fry reside can kill salmon directly, or indirectly increase mortality by carrying them downstream and away from stream cover.³⁶

Distinguishing between urban streams and larger bodies of water relative to the effect of stormwater runoff is important. The previous discussion has focused on urban streams where the effects of runoff on water quality and quantity are the greatest. Large bodies of water, such as Lake Washington and the Puget Sound shoreline, apparently have the least susceptibility to many of the environmental factors listed above. The relatively large volume of water in these salmon environments makes them more resilient

Porous Pavement Brief Description

Porous pavement, first engineered by researchers at the Franklin Institute in Philadelphia in the 1970's, is an asphalt paving mixture with the properties of conventional asphalt, but is constructed using an aggregate mix that minimizes the presence of fine particles, allowing rainfall to drain through the pavement. Under the pavement is a crushed stone storage bed that receives rainfall from the pavement and inflow from other impervious surfaces such as rooftops and driveways.

Beginning in 2001, the Washington Aggregate & Concrete Association (WACA) has partnered with the City of Seattle to develop standards and specifications for permeable paving appropriate for the Seattle region, with existing and prospective demonstration projects underway. According to WACA Executive Director Bruce Chatkin, any soil type including glacial till is applicable for permeable paving with appropriate adjustments to the mix design to accommodate different soil types. Mr. Chatkin foresees a time when surfaces such as subdivision streets, sidewalks, and parking lots will be converted to pervious paving, thereby eliminating stormwater vs. continuing to treat and manage stormwater as occurs today. He acknowledges that to be successful, such a strategy will require changes in maintenance techniques and a systemic overhaul in practices associated with how pavements are designed and constructed.³⁷

Table 6: Benefits of Porous Paving

courtesy of Cahill Associates, an environmental consulting firm with over 25 years experience installing porous paving

Environmental	reduces amount of impervious surface from development
	reduces volume of stormwater runoff and peak rate of fine . . .
	reduces discharge of pollutants and improves water quality
	facilitates groundwater recharge to maintain groundwater levels and base flow in streams
	reduces drainage problems associated with stream channelization and sinkholes
Economic	reduces land space consumed by conventional detention facilities
	reduces need for curbs, gutters, inlets, and storm sewers
Aesthetic	Eliminates need for unsightly detention basins, rip-rap channels, etc.
	preserves areas such as woods or open space otherwise affected by detention basin
	eliminates puddling and flooding on parking lots

Salmon and Buildings

to short term environmental stresses than small rivers and urban streams. For example, stormwater runoff may temporarily impact a localized area of a lake or shoreline, but the (typically) short duration and dilution of the runoff will likely limit the negative effect on salmon habitat in proximity to the runoff event.

Outside the City of Seattle, particularly in the two surrounding watersheds, the Cedar/Sammamish and the Green/Duwamish, (see Figure 5), all of the environmental factors listed in Table 1 play a role in contributing to salmon habitat loss and degradation. Factors affecting water quality include the presence of contaminants and/or pollutants in some tributaries, sedimentation, and increasing water temperatures (apparently weather induced). Factors affecting water quantity/flow include high and low water level problems associated with uncontrolled stormwater runoff and a large number of flood control structures and diversions that are barriers to salmon migration.

Salmon-Friendly LEED™ Overlay for Sustainable Sites

Prerequisite 1: Erosion and Sedimentation Control

RECOMMENDED ACTION:

- Implement best stormwater management practices.

Follow practices established in the Washington Department of Ecology in “Stormwater Management Manual for Western Washington”, August 2001.

Credit 1: Site Selection

RECOMMENDED ACTION:

- Avoid construction in riparian areas.
- In riparian areas, establish buffer zones.

In riparian areas, buffer zones should range from 25 feet to 100 feet depending upon slope and stream size. For slopes equal to or greater than 10%, buffer zones should be no less than 50 feet.³⁸

Credit 2: Urban Redevelopment

RECOMMENDED ACTION:

- New construction should not exceed 10% net impervious cover.
- Existing buildings should diminish their net impervious cover to approximate the 10% benchmark.

Along with other researchers, the State of Washington Department of Fish and Wildlife acknowledges that 10% is an impervious cover limit required to ensure ecosystem health; instream functions and value begin to deteriorate when the imperviousness exceeds this value. Since the percentage of imperviousness exceeds 10% in most urban watersheds, existing buildings should be evaluated to determine how to diminish their net imperviousness, and new construction should be designed to comply with no new effective impervious

standards in watersheds that exceed 10%.

Credit 3: Brownfield Redevelopment

RECOMMENDED ACTION:

- Avoid uncontrolled release of hazardous materials from contaminated construction sites.

Ensure that disturbance of contaminated site does not result in the uncontrolled release of hazardous materials, as with stormwater run-off, particularly in watersheds with salmon habitat. (Note: all watersheds in the tri-county region have salmon habitat.)

Credit 5.1: Reduced Site Disturbance

See benefits of reduced total impervious area identified in Credit 2 above.

Credit 5.2: Reduce Development Footprint

See benefits of reduced total impervious area identified in Credit 2 above

Credit 6: Stormwater Management

RECOMMENDED ACTION:

- Control sources of contamination.
- Minimize amount of stormwater generated.
- Remove contaminants from stormwater.

Responsible stormwater management requires a three-phase strategy: control sources of contamination, minimize amount of stormwater generated, and remove contaminants from stormwater that is generated.³⁹

Controlling Sources of Contamination

- Require animal waste collection
- Implement Best Management Practices

**Green Roof
Brief Description**

Green roofs, or eco-roofs are a living vegetated roofing alternative which cover otherwise impervious roof surfaces with regionally-adapted plant species grown in a permeable soil matrix. Depending on rain intensity and soil depth, green roofs are estimated to reduce runoff by 15% to 90% for a single storm event⁴⁰ with the average annual runoff reduction estimated between 50% to 60%.⁴¹ This approach reaps additional benefits including longer roof life, sound attenuation, increased insulation value, absorption of CO₂, production of O₂, and reduced heat island effect.

Green roof costs can range from \$11 to \$20 per square foot dependent on factors such as roof slope, insulation requirement, building height, special permitting, type of vegetation, and capacity for human habitation. A recent green roof project in Seattle was bid at approximately \$15 per square foot, while the green roof installed on the recently completed Jean Vulliamy Natural Capital Center in Portland, Oregon cost \$11 per square foot. Price estimates for a green roof system based on international experience average about \$20 per square foot. These prices are two to three times higher than a conventional modified bitumen built-up roof, about \$5.50 to \$6.00 per square foot.

for hot spots such as car washes, gas stations, and fuel transfer or storage areas (See practices promoted by Seattle Public Utility, Washington Department of Ecology, and the King County Industrial Waste Program (www.ci.seattle.wa.us/util/surfacewater/businessinspect.htm)).

- Reduce fertilizer and pesticide use

Generating Less Runoff

(primarily a function of the impervious surface area)

- Reduce impervious surfaces
- Decouple impervious areas
- Eliminate curbs
- Collect rainwater off the roof
- Install porous pavement where appropriate (determine whether soil type is compatible with porous pavement; Seattle's glacial till soils may represent challenges to achieve desired performance)
- Install Green roofs (see sidebar)

Cleaning up the Stormwater that is Generated

LEED™ 2.0 specifies a limit on the total suspended solids and total phosphorous for stormwater runoff in a performance-based requirement. We recommend placing a limit on all pollutants listed in Table 5, and employing mitigation strategies such as structural (dry and wet detention ponds, infiltration basins, infiltration trenches, porous pavement), and proprietary treatment systems that are most cost effectively applied when there is limited available land. Monitoring is an essential element to verify performance relative to the standard, and to prompt appropriate system modifications.

Credit 7: Landscape and Exterior Design to Reduce Heat Islands

RECOMMENDED ACTION:

- Maximize shading strategies.

- Maximize pervious surfaces.

Pursue shading strategies (natural vegetation and constructed shade structures) to lessen the heat build-up on impervious surfaces; employ green roofs, pervious paving, and rainwater harvesting to lessen stormwater run-off quantity.

Since all of the LEED™ requirements in this category encourage water conservation, they relate to water *quantity* rather than *quality*. In addition to reducing demand on Seattle’s freshwater supplies, water efficiency also reduces electrical demand by reducing pumping requirements and offsetting the energy used to heat water.

Seattle’s freshwater supply comes from the rain and snowmelt in two eastern watersheds: the South Fork Tolt River Watershed supplies one third of the water for Seattle’s 1.3 million people, while the Cedar River Watershed supplies the balance. Both watersheds comprise large uninhabited areas. The City is responsible for managing not only their hydrology, but also the associated land, forests, and wildlife. According to Seattle Public Utilities’ Bruce Flory, in 2001 and 2002 the City provided an average 140 million gallons per day (mgd). In addition to providing a water source, the Cedar River Watershed has a hydro plant, providing 1% of Seattle City Light’s electricity supply. As an indicator of Seattle’s aggressive water conservation initiatives, SPU’s baseline water demand is projected not to exceed 200 million gallons per day in the forecasted time horizon, though these are only estimates and can’t account for unforeseen changes in supply and demand.

Impacts to Salmon

Withdrawing freshwater for irrigation, power generation, industrial and municipal uses can result in an array of impacts on salmonid essential fish habitat (EFH), including physical diversion and injury to salmon, impediments to migration, changes in sediment and large woody debris transport and storage, altered flow and temperature regimes, and water level

fluctuations. Reduced water levels may result in a higher concentration of pollutants in rivers and streams; these reduced water levels may also effect an aquatic system’s biological components including riparian vegetation. As the manager of both the Tolt River and Cedar River watersheds, the City of Seattle must consider these impacts while balancing the freshwater needs of human and salmon populations. Seattle’s impressive stewardship is setting the standard for salmon habitat protection and restoration.

In the Cedar River Watershed, several species found downstream of Landsburg, where the City withdraws its water, are either already listed under the Endangered Species Act, are proposed for listing, or are at risk, including coho, chinook, and sockeye salmon, as well as bull and steelhead trout.⁴² In response, the City of Seattle has developed the Cedar River Watershed Habitat Conservation Plan (HCP) through which it has made a 50 year commitment to programs designed to provide significant benefits to fish and wildlife. This plan was developed in collaboration with state and federal agencies, with input from tribal biologists and regional scientists, and commits \$89 million to improving conditions for fish and other wildlife. For example, \$38 million has been allocated “to protect and restore habitats and populations of anadromous fish currently blocked from entry into the municipal watershed by the Landsburg Diversion Dam”.⁴³

The situation in the Tolt River Watershed is similar, where summer run steelhead trout, coho, and chinook salmon are all potential candidates for endangered species listings. Since none of these species have yet been declared endangered, a habitat conservation plan has not been pursued to date. Instead, the Tolt Fish

Habitat Restoration Group was formed, a partnership comprised of members representing 14 state, federal, county, tribal, environmental, public utility, and academic organizations. This group prioritizes projects based on potential biological benefit, and gives preference to protect and restore critical spawning and rearing habitat in the basin.⁴⁴ Projects range from removal of fish passage barriers to continuous temperature measurement in the South Fork Tolt River to monitor the impact of water releases from the reservoir and from the hydropower project.

Salmon Friendly LEED™ Overlay for *Water Efficiency*

The City of Seattle has aggressively pursued water conservation, as demonstrated by Seattle Public Utility's "1% for Conservation" program, designed to reduce demand by 30 million gallons per day by the year 2040. The Utility should be commended for having met the goal of 1% reduction every year since 1980. The authors acknowledge the measures already underway in Seattle and the surrounding region, and encourage building designers, owners, and operators to maximize water reduction schemes according to the LEED™ credits listed below. Look to the U.S. Green Building Council's LEED™ Reference Guide for recommended strategies. As some of these strategies are eligible for utility-funded rebates, building owners, operators and facility managers should check with their local utility to determine eligibility. For example, Seattle Public Utilities offers incentives for beyond-code fixtures such as waterless urinals, which are well-documented to dramatically reduce water use in commercial facilities.

urinals in commercial buildings.

A study conducted by Seattle Public Utilities found that the dual-flush toilet reduced water use by 24% beyond the savings achieved from a 1.6 gallon per flush toilet, while waterless urinals are recognized to dramatically lower water consumption in commercial buildings.

Credit 1: Water Efficient Landscaping

RECOMMENDED ACTION:

- Maximize the use of native plants in landscaping to reduce irrigation requirements.
- Employ greywater and captured rainwater for irrigation.

Credit 2: Innovative Wastewater Technologies

RECOMMENDED ACTION:

- Redirect greywater and captured rainwater to use in toilet flushing.

Credit 3: Water Use Reduction

RECOMMENDED ACTION:

- Install dual-flush toilets and waterless

The quantitative and qualitative aspects of energy supply and its atmospheric consequences appear to affect salmon much as they do people and other life forms. Though less directly than the release of a toxic substance into a body of water, studies indicate that global climate change and stratospheric ozone layer depletion may contribute to salmon decline.

In aggregate, producing electricity has significant environmental burdens, releasing as by-products nearly two-thirds of U.S. sulfur dioxide, one-third of ground-level ozone precursors nitric oxide and nitrogen oxide, and one-third of carbon dioxide emissions. Because more than half of Washington State's electricity is generated by hydroelectric facilities, Washington is relieved of many of the environmental burdens faced by much of the rest of the U.S. However, hydroelectric facilities pose a different set of environmental challenges that potentially affect salmon.⁴⁵

Seattle City Lights' hydro-dominated energy grid reflects the region's historical water abundance, with 94.6% of supply provided by seven hydropower facilities, three of which are owned and operated by the City and located on the Skagit River, a prime habitat for endangered salmon. The remaining 5.4% of energy supply is provided by wind power and natural gas, among other market options. A plant in Oregon provides the portion of energy generated using natural gas, replacing energy formerly supplied by the coal-fired Centralia plant, the second largest sulfur dioxide emission source in the western United States.⁴⁶ As a more cost-competitive substitution for hydroelectric than other renewable sources, shifting supply to natural gas will increase the greenhouse gas contribution associated with Seattle's energy grid. An opportunity exists, in the transition to competition, to accelerate

the introduction of new, cleaner technologies. Since energy is paid for in both economic and environmental currencies, competition should aim to ensure that costs are decreased in all currencies, rather than shifting costs between the economic and environmental categories. Continuing in its commitment to move away from dependency on nonrenewable energy resources, Seattle City Light began purchasing electricity from the Stateline Wind Project in January 2002. Currently, SCL receives the electricity associated with 50 MW of capacity of the plant. This amount will increase in August 2002 to 100 MW, ramping up to as much as 175 MW in 2004.

Historically, the City of Seattle's commercial energy code has been among the most stringent in the country, with annual goals set to purchase the equivalent of 6-2 aMW of avoided generation through conservation. Typically, these goals, which vary from year to year, have been exceeded. Moving forward, the development of a salmon-friendly energy grid requires attention to both supply and demand. Relative to demand, Seattle is halfway to meeting its 10% electricity reduction goal,⁴⁷ while on the supply side, Seattle is pursuing several salmon-friendly energy options in addition to working towards a policy initiative to become greenhouse gas neutral. This resolution, passed by Seattle City Council in April 2000, established "...a long-range goal of meeting the electric needs of Seattle with no net greenhouse gas emissions."⁴⁸ The "Earth Day 2000" resolution quoted above was further reinforced by the net zero greenhouse gas emissions resolution, which lists energy conservation and purchasing renewables as preferable to mitigation strategies.⁴⁹ In response, Seattle City Light (SCL) developed the Greenhouse Gas Mitigation

Table 7: Low Impact Hydropower Institute (LIHI) Criteria

- river flows
- water quality
- fish passage and protection
- watershed protection
- threatened and endangered species protection
- cultural resource protection
- recreation
- facilities recommended for removal

Program, with a goal to offset the CO₂ emissions from its purchase of electricity from the Klamath Cogeneration plant by the end of 2002, and for its entire greenhouse gas footprint in 2003. Moreover, an effort is underway to further diversify the grid through renewable, non-carbon sources such as biomass, geothermal, hydroelectric, solar, wind, and landfill and wastewater treatment methane gas. Pursuing the dual strategy of reducing demand and transitioning to an electrical grid combining low-impact hydro, other renewables such as wind and solar photovoltaics, and cleaner burning natural gas will lessen the impacts associated with more conventional energy generation and assist the City's goal to comply with the Kyoto Protocol.

Impacts to Salmon

The major impacts to salmon for this LEED™ category are hydropower, greenhouse gas emissions, and ozone depletion.

Hydropower and Salmon

Although technically a renewable resource, hydro facilities as conventionally designed and operated are treacherous for salmon. According to researcher Patrick Mazza, 95% of salmon mortality in the Columbia River is linked to dams.⁵⁰ Dams can completely block the upstream migration of fish, even if equipped with fish ladders. Moreover, the reservoirs created by dams lack the current needed to guide juvenile salmon to the ocean. This can be critical to fish that have evolved to transform themselves to life in saltwater at a particular time or stage of development. Slower migration to the sea also exposes young salmon to more predators. By slowing down water and creating large lakes, dams can also cause the river's water temperature to rise, which can be fatal to fish. Additionally, dams capture the peak run-off to use later in the year, thus often

eliminating the spring freshets that hasten the salmon to the sea, and restrict high winter flows that would normally fill the river, thus enabling adults of winter runs to reach their spawning grounds.⁵¹ At other times, so much water is released at such high velocity that it sweeps fish out of the river before they are ready, and washes away small gravel and sediment below dams. "Pumps and turbines in dams often suck up fish and kill them, and fish that go over the dam spillway often get gas bubble disease from the water's extreme turbulence."⁵²

Responding to these breaches, strategies have emerged to lessen hydro-related impacts to salmon and other aquatic species. "Low impact hydro," now adopted by several jurisdictions, is a carefully designed, implemented and evolving refinement to the technology, with specific protocols to ensure compatibility with salmon. Indeed, in August 1998 the Portland, Oregon City Council passed a resolution urging utility companies to offer customers a salmon-friendly power option. According to For the Sake of Salmon's Executive Director, Bill Bradbury, "Portland is the very first city to pass this kind of resolution and take the discussion seriously." The intent of the resolution is to generate hydropower electricity that doesn't harm fish, particularly providing adequate fish-passage.

Seattle's commitment to salmon-friendly hydro extends back several decades, and predates the standardization of salmon-friendly hydro protocols developed by the Low Impact Hydro Institute (LIHI), that certifies hydroelectric power facilities that meet certain criteria (see sidebar). Beginning in 1989, Seattle City Light (SCL) adopted a 'Fish First' strategy focused on the preservation and protection of fisheries resources in the Skagit River basin. Chum, pink, and chinook salmon populations have either increased in abundance or stabilized in the 1990's as a result of this effort. Such improvement stands in stark contrast to other area rivers,

many of whose salmon populations continue to dwindle.

In 1991, Seattle City Lights entered into Settlement Agreements with twelve stakeholders as part of project re-licensing. The agreements designate that the Skagit dams regulate water flow to mitigate environmental damage both to salmonids and their habitat. These efforts have bolstered SCL's progress towards protecting salmon since 1981 when dam operations were first modified. Since that time, maximum flows are limited during salmon spawning period, minimum flows are designated during salmon incubation, and large water releases are not allowed when salmon fry are abundant. In 1999, before the Low Impact Hydropower Institute had officially issued its criteria and before it was accepting applications, Seattle City Light prepared a report, based on LIHI draft certification standards from 1997, for the three plants on the Skagit – the Gorge, Diablo and Ross dams (referred to collectively as the Skagit River Hydroelectric Project). The electricity output from these dams, on average, constitutes about 24% of SCL's total electric portfolio. Because all three dams are located upriver from the historical limit of anadromous salmon migrations, they avoid the problems associated with allowing salmon to pass over the dam. While timing did not permit SCL to seek LIHI certification for these dams, the Skagit River Hydroelectric Project meets all of LIHI's requirements and has received third party certification. Indeed, the report was submitted to the Northwest Energy Coalition, Renewables Northwest Project, and the Natural Resources Defense Council for review, and each endorsed it as an environmentally preferred project.⁵³

Because the Skagit River Hydroelectric Project meets the LIHI requirements (though has not been officially certified), it fulfills the LEED™ requirement for Green Power (EA Credit 6). Indeed, a credit interpretation for the Seattle Justice Center for EA Credit 6 was approved in Fall 2002.⁵⁴

At least two other variations on the salmon-friendly hydropower theme are underway. As of March 1, 2002, Portland General Electric (PGE) and Pacific Power customers can purchase 100% renewable energy supplied by Green Mountain Energy Company. Those who choose Green Mountain's Salmon-Friendly Plan pay an additional monthly flat fee, a portion of which is donated to the non-profit Pacific Salmon Watershed Fund (PSWF), a 501(c)(3) charitable organization operated by the salmon recovery organization, For the Sake of the Salmon, and is used for salmon habitat restoration. Another supplier, Bonneville Power Administration, generates 15,000 of its 17,000 megawatts by what they term "green hydropower", though just 20 megawatts have received an eco-endorsement by environmental groups like Renewable Northwest and American Rivers.

The South Fork and Cedar Falls plants, representing only about 1.5% of SCL's energy portfolio, meet Green-E requirements as their capacity is less than 30 aMW. The South Fork Settlement Agreement, signed by Seattle City Light in the 1980's as part of the FERC re-licensing process, makes several further commitments to protect and improve salmon habitat affected by that facility. The Habitat Conservation Plan prepared by Seattle Public Utilities for the Cedar River Watershed under the Endangered Species Act will do much to protect drinking water for 1.3 million people and restore habitat for 83 fish species.

Seattle City Light's largest hydropower plant, Boundary, provides about 38% of the utility's energy portfolio. Like the Skagit dams, the Boundary plant is located above the reaches of salmon migrations. Positioned on one of the Pend Oreille, a branch of the Columbia River, the facility minimizes water flow impact to salmonids living downstream using operational criteria developed by the National Marine Fisheries Service for the Federal Columbia River Power System.

Fluctuating the amount of water allowed through the dam in accordance with seasonal river flows can reduce the annual energy available from the Boundary plant by as much as 30 aMW.

Greenhouse Gas Emissions and Global Warming

Much of the current interest in energy efficiency is driven by well established concerns of fossil fuel emissions' contribution to global warming. Studies are beginning to emerge that establish correlation between salmon survival and global warming. Since this will affect both oceans and streams, global warming will impact salmon at all stages of their life cycle. Warming trends in the Pacific Ocean, in part attributed to global warming, have been linked to a drop in salmon population. Researchers suspect that the warmer water results in a stratification such that nutrients are trapped far below the migrating salmon inhabiting the upper ocean.⁵⁵ In a draft document prepared by the Northwest Fisheries Science Center, data suggest that "...salmon populations also appear to be affected by variation in ocean conditions associated with short- and long-term climatic fluctuations. ...These temperature changes affect phytoplankton production, which in turn affects zooplankton abundance. ..."56 The projected 2° - 4° C increase in ocean surface temperature, combined with anticipated slowing of wind speeds, would affect ocean upwelling whereby waters from the depths rise to the surface, bringing nutrient-rich cold water needed for the salmon's food chain; cold water nutrients

feed zooplankton, which feed salmon.

For Washington State, the most dramatic effect of global warming is likely to be hydrological, and therefore a potential threat to the region's freshwater salmon population. In general, increased water temperature makes survival harder for the cold-water adapted salmon. Warmer water during incubation results in premature hatching and increased mortality. Winter floods resulting from unseasonably warm temperatures reduce survivability of young fry. The timing and flow volume of stream discharges, including spring snowmelt that take the salmon downriver, are altered by warming. During upstream migration, higher temperatures and lower volume increases mortality risks of adults going to spawn. However, recent findings that Puget Sound waters are *cooling* adds an additional dimension to the climate change puzzle.⁵⁷

Ozone Depletion

Salmon are vulnerable to increased exposure to ultraviolet radiation, a consequence of stratospheric ozone layer depletion, and are among the most threatened species because their eggs or larvae are in shallow waters in the early spring.⁵⁸

Based on 1999 TRI data, two tri-county building-related manufacturers reported use of Freon 113, an ozone depleting compound slated for a January 1, 1996 phase-out (see Table 8 below). In follow-up calls, General Plastics indicated it no longer uses Freon 113 having converted to 141B, an HCFC scheduled for phase-out in 2015; representatives from Johns Manville have not responded to our phone calls. Freon 113 has an ozone depleting potential of 1, while refrigerant 141B has an ozone depleting potential of 0.11.

Table 8: Tri-county Building Product Manufacturers using Ozone Depleting Chemicals

Facility	Product	Ozone Depleting Compound Used	Alternative
General Plastics Mfg. Co. 4910 Burlington Way Tacoma, WA 98409	Closed cell polyurethane foam board	Freon 113 (claim not to have used for 6-8 yrs); Acknowledged use of Freon 11	141B, an HCFC with phase-out scheduled for 2015
Johns Manville Intl. 7615 S. 212 th St. Kent, WA 98032	Polyisocyanurate roofing insulation	Freon 113	Not identified

Salmon and Buildings

Salmon-Friendly LEED™ Overlay for *Energy and Atmosphere*

Most of the prerequisites and requirements in this category are geared toward reducing energy demand, shifting to renewables, and eliminating ozone depleting compounds. EA Prerequisites 1 and 2, along with Credits 1, 3, and 5 are all about reducing demand: designing energy efficiency into the building, and then ensuring the efficient performance of the building at occupancy and for the rest of its life. Credits 2 and 6 require use of renewable energy, while Prerequisite 3 and Credit 4 advocate the use of non-ozone depleting compounds. The City of Seattle has one of the nation's most rigorous energy efficiency programs. The authors acknowledge the energy efficiency measures and incentives in Seattle and the surrounding region, and encourage building designers, owners, and operators to maximize strategies to reduce energy demand based on the LEED™ credits listed below. As some of these strategies are eligible for utility-funded rebates, building owners, operators and facility managers should check with their local utility to determine eligibility.

EA Prerequisite 3: CFC Reduction

RECOMMENDED ACTION:

- City of Seattle's procurement policies should enforce the Montreal Protocol regarding CFC products.
- City of Seattle should work with regional governments to pursue strategies to accelerate the phase-out of all ozone depleting compounds, including HCFCs, used by regional manufacturers.

City of Seattle's procurement policies should enforce the Montreal Protocol and require documentation to ensure that all products purchased by the City comply with the prescribed phase-out. Additionally, the City should work with regional governments to pursue strategies to accelerate the phase-out of all ozone depleting compounds, including

HCFCs, used by regional manufacturers. This recognizes salmon's vulnerability to increased exposure to ultraviolet radiation, a consequence of stratospheric ozone layer depletion caused by the release of CFCs, HCFCs and halons.

EA Credit 1: Optimize Energy Performance

RECOMMENDED ACTION:

- Meet and exceed the ASHRAE 90.1, 1999 standard, as well as the City of Seattle's energy performance requirements

EA Credit 2: Renewable Energy

RECOMMENDED ACTION:

- Identify non-hydro renewable sources such as wind, biomass, and photovoltaics, as well as salmon-friendly hydro.

EA Credit 3: Additional Commissioning

RECOMMENDED ACTION:

- Ensure that plumbing systems are included in recommissioning manual scope.

EA Credit 4: Ozone Depletion

RECOMMENDED ACTION:

- Balance reduction of ozone depleting compounds with global warming potential.
- Specify non-ozone depleting refrigerants and fire suppressants.

Balance reduction of ozone depleting compounds with global warming potential, recognizing that both are contributing factors to salmon decline;

Seattle City Light Green Power Option
Brief Description

Beginning January 1, 2002, in response to a state legislative mandate, Seattle City Light is offering customers a green power option. In the short term, this will be generated by wind and other non-hydro renewable sources, and thus has the potential to be Green-E compliant.³⁹

Since Seattle City Light has a monopoly on Seattle's electricity market, there is a unique opportunity to shift the market towards renewables. As mentioned above, SCL has already begun to enter the non-hydro renewable market with the launch of the Stateline Wind Project in January 2002. The 1996 report issued by the Comprehensive Review of the Northwest Energy System, a forum convened by the Northwest governors, provided the following recommendation to utilities in this regard: "modest investments in the following three areas: renewable research and development; direct application of renewables, such as geothermal district heating and solar hot water; and renewable resource "market transformation," including financing packages and other measures to develop the renewables market". The report speculates that in the short run, renewables will be at a competitive disadvantage in the wholesale market where cost is the primary criterion. However, in the longer term, renewables are expected to have an edge because of lower emissions and, more specifically, no greenhouse gas emissions.

specify non-ozone depleting refrigerants and fire suppressants as available and balanced with global warming potential. (See also EA Prerequisite 2, above.)

EA Credit 6: Green Power

RECOMMENDED ACTION:

- Comply with the Green-E Renewable Electricity Program for certification of renewable energy sources.

This LEED™ credit requires compliance with the Green-E Renewable Electricity Program for certification of renewable energy sources. As of this writing, no generating facility in Washington State has been certified through the Green-E program, though the Bonneville Environmental Foundation's Green Tag program, available to any Washington resident, has been Green-E rated. Hydroelectric power plants are eligible for Green-E certification if they produce 30 aMW or less, or if the plant has also been certified by the Low-Impact Hydropower Institute. (See sidebar on page 36 for LIHI criteria.) Beginning in 2002, Green-E equivalent certification can also be sought for plants over 30 aMW that become LIHI certified. Note that some green energy sources may comply with the Green-E requirements even without formal certification. Refer to the sidebar on this page for a description of the Green Power Option offered by Seattle City Light.

The focus of this section is threefold: (1) the *upstream* environmental burdens associated with the manufacture of building materials; (2) *substitution strategies* to accelerate reliance on targeted recycled-content and rapidly renewable resources as replacements for virgin materials; (3) *downstream* burdens associated with disposal of particular materials.

Impacts to Salmon

Studies have established that salmon are vulnerable to numerous biochemical consequences of manufacturing.

For example:

- **Embodied energy** (the energy associated with the extraction, processing and transportation phases of the life cycle prior to use) has a direct relationship to global warming potential, which may result in increased temperatures in the streams, rivers and oceans inhabited by salmon at various stages in their life cycle. It is important to note that there is uncertainty on the region-specific impacts associated with global warming in the Pacific Northwest, with some studies indicating that it could result in the cooling vs. warming of the Puget Sound;
- **Extractive industries**, including sand, gravel and forest resources, can alter ecosystems thus transforming the habitat conditions essential for salmon survival
- **Refrigerants and blowing agents** release CFCs and HCFCs, known to deteriorate the stratospheric ozone layer resulting in increased exposure to ultraviolet radiation. Although the internationally-sanctioned Montreal Protocol has banned CFCs and established a timetable for the

phase-out of HCFCs, there is evidence that both are still in use by building-related manufacturers in the Seattle region;

- **Chemically-intensive manufacturing**, such as with paint, plastics, and treated wood can result in chemical releases to water, land, and air that can directly and indirectly contaminate salmon habitats.

This section will address these issues relative to steel and concrete manufacturing, general mining, wood and agrifiber products, and toxic chemicals.

Embodied Energy

Three of Seattle City Lights' six top electrical customers are building-related industries: Birmingham Steel (#1), Ash Grove Cement (#5) and Lafarge Cement (#6), each of which have been exploring and adopting modifications to enhance operational efficiencies. Because Seattle's electrical grid is currently dominated by hydro-generation, these industries' associated CO₂ emissions, or global warming potential (GWP), is substantially less than for industries that rely on coal- and natural gas-based electrical generation. However, because of projected supply shifts, the future is likely to see a more diverse electrical generation grid in the northwest, characterized by decreasing hydro and/or shift to low-impact hydro and other renewables, and increasing percentages of natural gas and potentially coal.⁶⁰

Birmingham Steel operates a scrap-based mini-mill that produces steel and steel products, including steel reinforcing bar and rounds, squares, flats, angles, channel and strip sold to fabricators. As Seattle City Light's largest customer with consumption greater than 250,000 mwh per year, efforts have been

Impact of Mining on Water Quality
excerpt

"The mining industry recognizes the probability that mining has degraded the quality of America's surface waters more than any other component of the environment.... Between 1961 and 1975, for example, a conservatively estimated 10 million fish were killed by mining-related water pollution in the U.S. (U.S. EPA 1979)."⁶¹

underway to enhance Birmingham's energy efficiency, with benefits accruing to both the company (lower operating costs) and the City (lower demand). Sparked by the rolling black-outs of 2001 that imperiled electrical customers all along the west coast, Birmingham struck a deal with the City of Seattle in December 2001 providing for lower electricity rates in exchange for Birmingham's agreement to temporarily forego power on short notice during diminished generation capacity.

Seattle's two cement kilns, Ash Grove Cement and Lafarge Cement – the only ones in Washington State – also represent significant share of Seattle's elec-

tricity demand. For further discussion, see the Cement section in *Materials & Resources*, below.

Mining in General

Mining in Washington State includes carbonate, coal, metals, stone, sand and gravel. (See sidebar) The extent to which mining activities affect salmon essential fish habitat (EFH) reflects the type, extent, and location of the activities, and the extraction method: surface or underground mining. While underground mining can contribute to salmon decline, surface mining is considered to have greater potential to affect aquatic ecosystems.⁶² For example,

Figure 5: Washington State Mining Operations by County

Number of Sites with Active Washington State Department of Natural Resources (DNR) Reclamation Permits

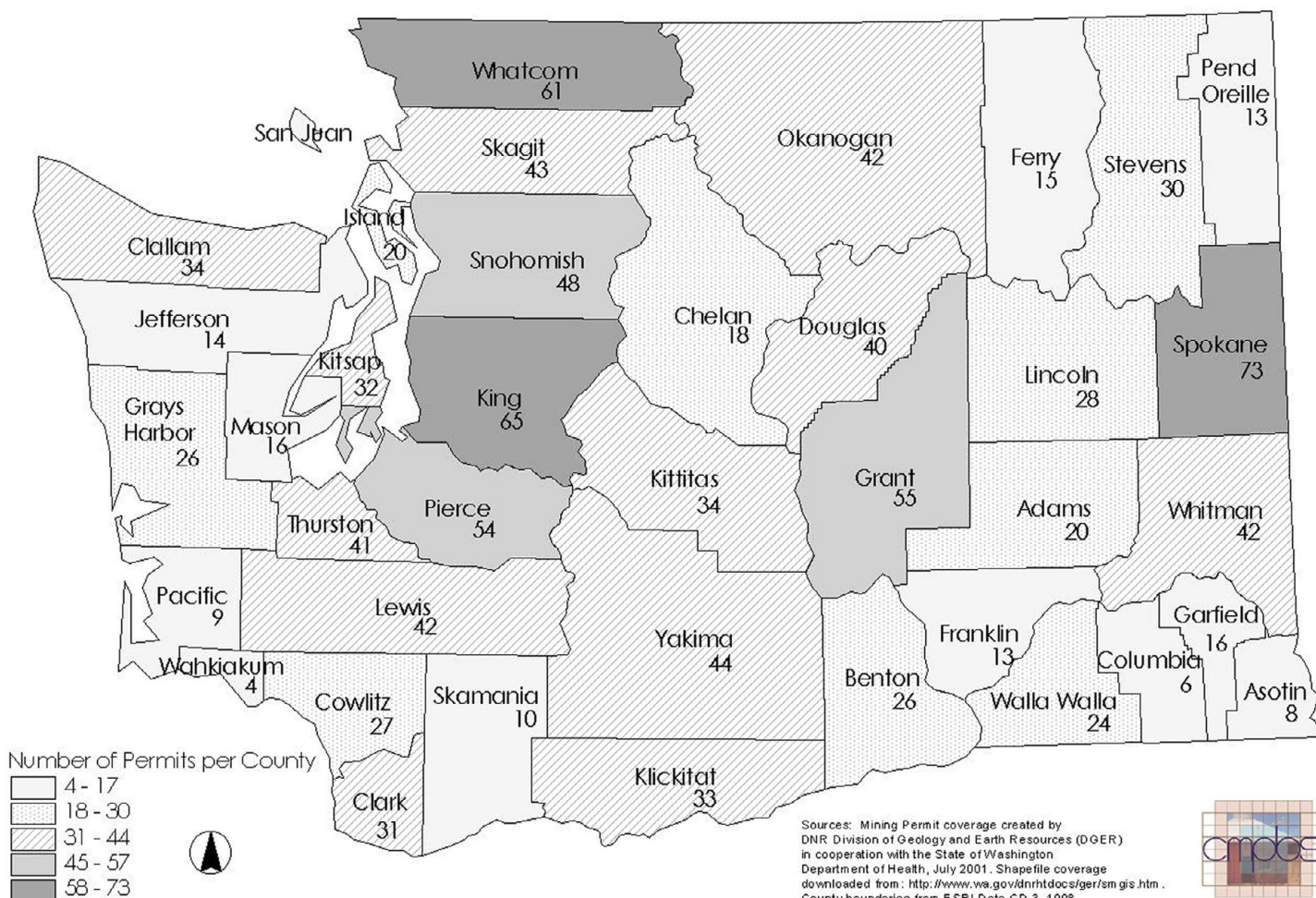
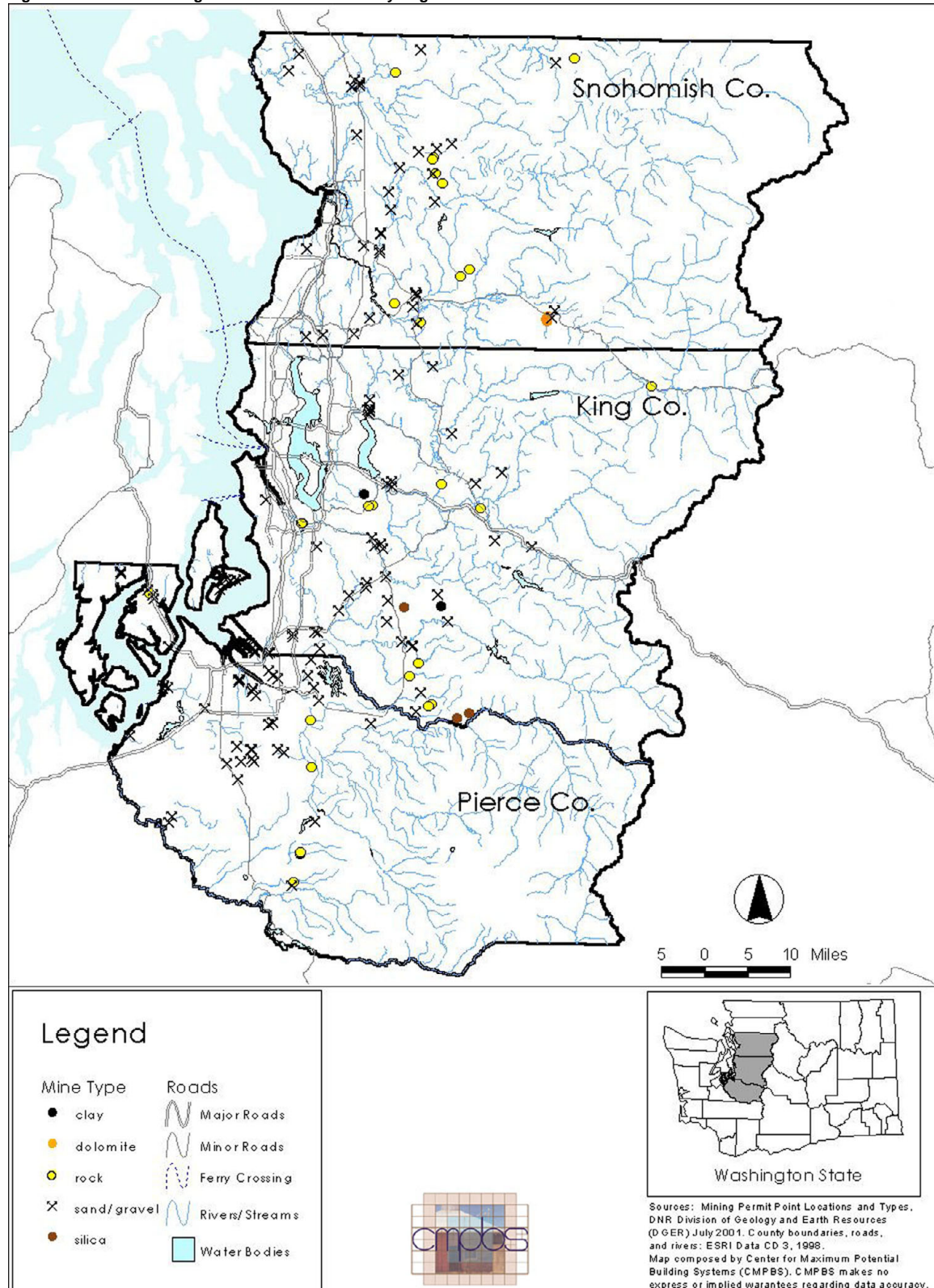


Figure 6: Permitted Mining Facilities in the Tri-County Region



"...surface mining typically increases sediment delivery much more per unit of disturbed area than other activities because of the level of disruption of soils, topography, and vegetation. Erosion from surface mining and spoils may be one of the greatest threats to salmonid habitats in the western US."⁶³ The Surface Mining Control and Reclamation Act (SMCRA) of 1977 states that mining activities must be performed so as to "minimize disturbances and adverse impacts of the operation on fish, wildlife and related environmental values, and achieve enhancement of such resources where practicable."⁶⁴ In addition, Washington Department of Ecology's 1994 Shoreline Management Guidebook recommends local governments encourage miners "to locate activities outside the shoreline jurisdiction", interpreted as 200 feet from the floodway, or off the 100-year floodplain.⁶⁵

Though hard rock (underground) mines operate from five to 15 years or until the minerals are depleted, contamination that happens as a consequence of mining activities can continue for hundreds or thousands of years after mining operations have ceased.⁶⁶ These sites can produce heavy-metal effluent affecting water quality and pose risks to fish and other resident biological communities. Based on epidemiological principles, strong correlation has been established between heightened levels of heavy metals and the condition of invertebrate communities in impacted creeks. Specifically, according to the University of Washington's Center for Streamside Studies, "Elevated concentrations of cadmium, copper, selenium, and zinc in streamwater and sediments have reduced species diversity and abundance in these aquatic communities. Contaminated headwater streams are significant hazards to the environment and threaten juvenile salmonids, including bull trout, native steelhead, and chinook salmon..."⁶⁷

Although Washington Aggregate & Concrete Association's Bruce Chatkin considers existing regulatory structure sufficient, the authors' communications with government representatives revealed inconsistent enforcement of protective measures. With significant increased demand projected for sand and gravel,⁶⁸ monitoring and verification of compliance with these standards should be ensured.

Concrete: Portland Cement, Sand, and Gravel

Comprised of about 11% portland cement, 41% gravel or crushed stone, 26% sand (fine aggregate), 6% air and 16% water, concrete is one of the most widely used materials in contemporary construction. Concrete's durability, low maintenance, and high mass characteristics make it well-suited for both residential and commercial applications. For example, about 230 tons of sand and gravel and related products are used to construct an average 2,000 square foot residence in Washington.⁶⁹ Depending on how and where these raw materials are sourced, extracted, and manufactured, the level of environmental impact can vary. The greatest environmental impact for portland cement comes from the manufacturing process, while the greatest impact for sand and gravel comes from the extraction process.

Portland Cement

Portland cement is manufactured from a source of calcium, such as limestone, a source of silicon, such as sand or clay, and small amounts of bauxite, iron ore, and gypsum.⁷⁰ The primary manufacturing process occurs in a large rotary kiln which reaches a temperature of 2700° F. This high temperature process is the reason that cement manufacturers are some of Seattle City Light's largest customers. Both of Washington State's two cement kilns, Ash Grove and Lafarge, are located in Seattle on the Duwamish Waterway. In addition to electricity purchased from Seattle City Light,

both plants are permitted to burn a variety of other fuels to support their operations, primarily coal and petroleum coke, with significantly smaller percentages of other permissible fuels such as tire derived fuel (tdf) and natural gas.

Worldwide production of portland cement accounts for 7-10% of CO₂ emissions and a proportionate contribution to global warming. Because of the 50% CO₂ contribution associated with calcination, even cement plants that rely on electricity generated by hydropower (as is the case with the Seattle facilities) still have significant CO₂ emissions, though less than industry averages.⁷¹

Of Seattle's two portland cement facilities, Ash Grove is the largest producer and the most efficient, having converted from a "wet" process to a "dry" process with the opening of their new plant in 1992. The dry process has several advantages, two of which are particularly relevant to salmon: water consumption and emissions.

Water Consumption: The dry process significantly lessens water use and discharge with all wastewater flowing to the City's sanitary sewer system. Lafarge is curbing their fresh water demand by participating in a Seattle Public Utilities-sponsored reuse project that will direct industrial, process, and stormwater to the cement plant for reuse in their cement manufacturing process. The projected water savings, yet to be realized as of this writing, should reach about 6.2 million gallons per year.⁷²

Energy Intensity: The dry process requires less energy per unit of output than the wet process (about 8.3 tons / MWh for Ash Grove vs. 9.2 tons / MWh for Lafarge).

Emissions: Although the Lafarge plant produces more cement per megawatt-hour of electricity consumed, it produces more CO₂ per ton of cement than the Ash Grove

plant because of the combustion of other fuels in the manufacturing process. Thus, the Lafarge plant makes a greater contribution to global warming per unit product by about 1%. In each of the emissions categories measured by Puget Sound Clean Air Agency, except for carbon monoxide, levels for Ash Grove were less than for Lafarge, even with a higher level of output. The higher carbon monoxide emissions may be a function of the dry vs. wet process, one area where that process does not yield a measurable benefit.⁷³

Sand and Gravel Aggregates

Washington State's construction activities consume nearly 80 million tons of sand, gravel and crushed rock products each year, or the equivalent of about 15 tons of aggregate per person per year. The State's abundant aggregate resources, representing the fifth largest supply in the U.S., result from glacial activity that occurred 15,000 to 18,000 years ago. Indeed, sand and gravel represent Washington's most valuable production mineral commodity.⁷⁴

Aggregates are heavy and expensive to transport. With transportation representing 45% of their cost, about 20-25 cents per mile per ton, there are compelling economic incentives to locate supply sources close to the point of use. Reflecting transportation's impact on pricing, the Washington Aggregate & Concrete Association estimates that aggregates are most commonly used within a 25 to 35 mile radius of origin.⁷⁵ This puts a tremendous burden on resources closely located to areas experiencing high levels of construction activity, especially when those sources are coincident with salmon habitat. Recognizing that mining activities can have severe consequences on fish and other wildlife habitat, there is general guidance for large gravel mines to be located in uplands away from the river valley floors; less desired is for mining to be located on

terraces and the inactive flood plain, or above the 100-year flood plain. In Washington, mining upland deposits is considered to eliminate the potential for stream capture or river avulsion, and to improve likelihood of successful long-term reclamation.⁷⁶

Between 1970 and 1991, about one-sixth of Washington's gravel production was removed from riverine sources and located on flood plains and active gravel bars.⁷⁷ Despite claims that gravel extraction can be beneficial for salmon, there is broad consensus that it does not result in any general ecosystem benefits, with specific impacts reflecting the method and location of the extraction activities. Indeed, numerous policy directives clearly establish the conflict between gravel extraction and salmon survival, whether the mining activity occurs near an essential salmon habitat (ESH) or some distance away. See Table 9 for a discussion of gravel extraction methods.

NMFS National Gravel Extraction Policy

In 1996, the National Marine Fisheries Service (NMFS), a division of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), issued the "NMFS National Gravel Extraction Policy". The report describes its purpose as providing: "...general policy, procedures, and recommendations of NMFS's National Habitat Program pertaining to any gravel extraction projects within or near current or historic anadromous fish habitat....The intent of the Gravel Policy is to strengthen NMFS efforts in conserving anadromous fish habitat and to foster consistency at the national level, while maintaining regional flexibility....The Gravel Policy is designed to be robust in its protection of anadromous fishes and their habitats."⁷⁸

Key findings of the NMFS Gravel Policy include:

- A national policy on gravel extraction is

necessary because extraction in and near anadromous fish streams causes many adverse impacts to fishes and their habitats;

- Gravel extraction operations should not interfere with anadromous fish migration, spawning, or rearing, nor should they be allowed within, upstream, or downstream of anadromous fish spawning grounds;

- Extracting gravel from within or near a stream bed directly impacts a stream's physical habitat parameters by altering the flow patterns resulting from modifying the river bed and increasing suspended sediments. These changes result in reduced fish populations in the disturbed area, replacement of one species by another, replacement of one age group by another, or a shift in the species and age distributions.

Other sediment-related concerns include:

- Resuspended sediments may contain heavy metals, pesticides, herbicides and other chemicals that can be toxic to salmon and their prey;⁷⁹

- Sedimentation may be a delayed impact because gravel removal typically occurs at low flow when the stream has the least capacity to transport the fines out of the system;

- Fine sediments are detrimental to incubating fish eggs and may also inhibit larval, juvenile and adult behavior, migration, or spawning;

- Siltation, substrate disturbances and increased turbidity also affect invertebrate food sources of anadromous fishes.

- Extraction of bed material that exceeds natural replenishment by upstream transport causes bed degradation, reducing the amount of usable anadromous spawning habitat. Mechanical disturbance of spawning beds may result in high mortality rates of eggs and alevins;

Table 9: Gravel extraction methods

Wet-pit mining	extracts sand and gravel from seasonally exposed stream gravel bars below the water table;
Dry-pit mining	extracts sand and gravel from exposed bars and ephemeral streambeds excavated by bulldozers, scrapers, and loaders;
Bar scalping or skimming	removes the tops of river gravel bars without excavating below the summer water (common practice);
Excavation of floodplain and river terrace deposits	adjacent to an active or former channel.

- Bed degradation changes the morphology of the channel, potentially exposing the fish to higher temperatures, lower dissolved oxygen, increased predation compared to fish in the main channel, desiccation if the area dries out, and freezing;

- Gravel bar skimming significantly impacts aquatic habitat, thus increasing the susceptibility of downstream salmon redds (nests) to deposition of displaced, surplus alluvial material resulting in egg suffocation or suppressed salmon fry emergence; upstream redds are vulnerable to regressive erosion.

Additional impacts to salmon associated with the extraction of sand and gravel include:

- Decreased nutrients from loss of floodplain connection and riparian vegetation;

- Removal or disturbance of instream roughness elements during gravel extraction activities negatively affects both quality and quantity of anadromous fish habitat. For example, the removal of large woody debris, which helps provide critical freshwater habitat, results in an immediate decline in salmonid abundance;

- Stockpiles and overburden left in the floodplain can alter channel hydraulics during high flows, potentially blocking or entrapping fish and increasing downstream sedimentation;

- Herbicides used to clear vegetation may be used in riparian areas where they may enter water bodies. Exposure to herbicides can have lethal and sublethal effects on salmonids, aquatic invertebrates, aquatic vegetation, as well as target and non-target riparian vegetation;⁸⁰

Included in a list of indirect sources of water pollution affecting salmon habitat are gravel and rock crushing operations, characterized as carrying oil and other

hydrocarbons, heavy metals, sediment and other pathogens. The introduction of these pollutants can be lethal to salmon, or have long term chronic impacts that impair their survival.⁸¹

As the map in Figure 6 (page 43) illustrates, there is an abundance of sand and gravel activity in the tri-county region, accounting for almost 9,000 acres. In 1999, recognizing the potential conflict between mining and habitat protection, House Bill 1284 was proposed to fund a study of sand, gravel, and rock resource mining and its impact on salmon habitat and urban development. Current evaluations predict that existing mines will be unable to fulfill future demand for sand, gravel or rock. The study would identify environmentally sound sand, gravel and rock deposits.

Though the bill was not passed, it identifies a recommended course of action:

- Evaluate impacts of sand and gravel excavation in floodplains on spawning and rearing habitat of salmonid and freshwater species;

- Recommend whether additional controls are needed for sand and gravel extraction in floodplains to protect fish resources;

- Evaluate the expected life of known and designated sand and gravel deposits within an economically viable transport distance from major urban areas;

- Evaluate current sand, gravel, and rock consumption and projected sand, gravel and rock consumption trends for the next 50 years;

- Evaluate alternative sources of aggregate supply including recycling, reuse, conservation opportunities, and quarried rock;

- Recommend to local governments on mineral resource designation standards to protect known deposits of sand, rock, and

gravel to meet projected supply needs.

With an estimated cost of \$50,000, we recommend that the City of Seattle consider pursuing the elements of this study as outlined in the proposed legislation, perhaps in collaboration with other regional jurisdictions.

Wood and Agrifiber Products

In general, about 55% of wood cut for non-fuel purposes is used in buildings.⁸² Some researchers contend there is no inherent conflict between salmon and forests: "Waters in forested lands of western North America are major producers of anadromous salmon and trout....Areas that produce both timber and salmonids coincide over much of western North America, and the increasing public demand for both of these resources create frequent management conflicts. *Under most circumstances, both timber and fish can be successfully managed in the same watershed if measures to protect water quality and fish habitat are carefully coordinated with timber management operations.*"⁸³ (emphasis added) A literature review revealed numerous aspects of forest management impact salmon, such as timber harvests, roads, and the use of fertilizers and pesticides.

Change in the distribution and abundance of large woody debris (lwd) - logs greater than 51cm⁸⁴ - in streams constitute one of the most significant impacts. Harvesting practices can reduce the amount and size of lwd vs. that in nonharvested areas. This is important as the presence of lwd in streams is considered a fundamental component of creating and maintaining salmon habitat. Large woody debris contributes to the formation of pools (significant for both juvenile and adult salmon) and other important rearing areas, control of sediment and organic matter storage, and modification of water quality. In addition, lwd results in biological activities including blockages of fish migration, protection from predators and

high streamflow, and maintenance of organic matter processing sites within the benthic community. Also, lwd creates falls and riffles that mix oxygen and water, aerating the water.⁸⁵

Roads associated with forestry in particular, and in general, also contribute to habitat decline, increasing sediment delivered to streams through mass wasting and surface erosion. This can elevate the level of fine sediments in spawning gravels and fill substrate interstices that provide habitat for aquatic invertebrates. "*Poor road location, construction, and maintenance, as well as inadequate culverts result in forest roads contributing more sediment to nearby streams than any other forest activity*". (emphasis added) "On a per unit basis, mass wasting events associated with forest roads produce 26-34 times the volume of sediment as undisturbed forests."⁸⁶ Washington State's experience in this regard is alarming: "In Washington State, the number of large, deep pools in National Forest streams has decreased by as much as 58% due to sedimentation and loss of pool-forming structures such as boulders and large wood."⁸⁷

Profound changes in channel morphology, light, temperature, and flow regimes are associated with timber harvests. Removing riparian canopy reduces shading and increases the amount of solar radiation reaching the streams, resulting in higher maximum stream temperatures and increased daily stream temperature fluctuations, with even a 1-2°C increase affecting spawning and incubation. In addition, fertilizers, herbicides, and insecticides commonly used in forestry can be toxic to salmon directly if they enter surface waters, or may alter a stream's primary and secondary production, affecting the amount and type of food available to salmon.

LEED™ recognizes the Forest Stewardship Council (FSC) as the only approved certification entity for determining the environmental integrity of

wood products through the chain of custody (from forest to manufacturer). With the release of the Forest Stewardship Council's Pacific Coast Regional Standards (PCRS), currently in draft form (see sidebar), FSC provides specific recognition of the unique characteristics of forested lands in Washington, Oregon and California. The PCRS report cites significant remnants of primary old growth redwood and fir forests still standing; the intention of the standards is to protect them, recognizing that these intact forests are significant to maintain ecosystem processes such as refugia for fish, especially salmonids, and other wildlife.

Correspondence with Robert Hrubes, Senior Vice President, Scientific Certification Systems, one of the FSC-accredited certifiers, yielded pertinent information specific to the Forest Stewardship Council and salmon. All the following questions were posed by the authors, and all answers were provided by Mr. Hrubes:

Q: Does FSC-certified wood provide protection for salmon?

A: "FSC certification is designed to recognize forest management that is environmentally responsible, socially beneficial and economically viable. This implies a balancing of competing, multi-dimensional considerations. So I suppose it is therefore true that it does not entail "optimal" protections for salmonids, if you are defining "optimal" as uni-dimensional protection of salmonids without consideration of other environmental, social and economic tradeoffs. The same would hold for "optimal" protection for spotted owls, marbled murrelet, or any other single wildlife species. Not to mention indigenous people or local citizens....But such a conclusion would beg the question: with respect to assuring protection of salmonid habitat, what other certification system is superior to FSC? The clear answer is that there is no superior alternative."

Q: If the City of Seattle required all wood used in City projects to be FSC certified, would they be right to assume that the forest practices employed through the chain of custody are protective of salmon and their habitat?

A: "The answer is clearly yes, especially relative to wood associated with any other extant certification program."

Q: How should the FSC certification be modified to address salmon protection?

A: "Endangered species protection is expressly addressed in the context of FSC certification criteria. Could the standards be stronger with respect to salmonids? Yes, but certification criteria certainly aren't chopped liver with respect to watercourse management issues/salmonid protection in their present form."

Based on these responses, the LEED™ provision for specifying FSC-certified wood provides safeguards for salmon protection.

Agrifiber

Given the magnitude of wood use in buildings, particularly in the residential sector, salmon-friendly substitution strategies should be pursued. In addition to FSC-certified wood, agricultural by-products are a rapidly renewable resource that can be substituted for many wood-based products. About 60 million tons of wheat are generated in the U.S. each year,⁸⁹ with Washington State ranking third in U.S. total wheat production, producing on average seven percent of the nation's wheat crop. Five Washington State counties are among the top ten wheat producing counties in the U.S., including Whitman County at number one and Lincoln County at number two.⁹⁰ Despite the abundance of wheat straw, a by-product of wheat harvest, no manufacturer of straw-based building materials is located in Washington.⁹¹

The beneficial use of biomass, such as the production of wheat straw board,

Forest Stewardship Council's Pacific Coast Regional Standards (PCRS) brief description

In general, the PCRS rules "...require management to maintain and restore forest structures, functions, and processes; and to maintain biodiversity at many levels, natural soil characteristics, and hydrological characteristics, at both stand and landscape levels."⁸⁸

Salmon-Safe Certification Guidelines
Brief Description

The Salmon-Safe Certification Guidelines are designed to ensure that farm management practices utilize Best Management Practices (BMPs) to avoid harm, and where appropriate, enhance and restore the health of stream ecosystems. To avoid adverse impacts to salmonid stream ecosystem health, farm operations must address the principal forms of impact:

- Introduction into streams of sediment, energy (temperature) or chemicals from surface or sub-surface runoff;
- Elimination/reduction of riparian vegetation that serves as filters for chemicals and sediment in runoff, provides shade and cover along streams, and supports diverse communities of organisms, including those key to aquatic food chains;
- Direct alteration or disruption of in-stream habitat, stream banks, and streamside conditions through purposeful practices such as bank armoring, redirecting the course of streams, building dams, or inadvertent impacts resulting from excessive, poorly designed or inadequately maintained stream crossings; Alteration of stream flow regimes through stream water diversions or excessive groundwater pumping.

The procedures and evaluation standards have been implemented at more than 70 farms, orchards, vineyards, and dairies, and are continually refined based upon consultation with key stakeholders and pertinent experts.

(Excerpted from DRAFT Salmon-Safe™ Farm Management Certification Program: Field Assessor's Guidelines 4.0, Salmon-Safe Inc., June 2002, www.salmonsafe.org)

can have a positive impact on salmon. Since it provides a substitute for wood-based products such as particleboard and medium density fiberboard, it diminishes the load on forests. Even better, wheat straw derived from crops certified through the Salmon-Safe Farm Management Certification Program ensure that the wheat was grown in a manner protective of salmon.

Just as important, beneficial use of wheat straw offsets the environmental burdens associated with burning agricultural residue. The gases produced by biomass burning, including carbon dioxide and methane, and particulates, are all environmentally significant. Both carbon dioxide and methane are greenhouse gases, while combustion particulates affect the global radiation budget and climate. According to an article in *Environmental Science and Technology*, biomass burning accounts for 26% of net global carbon dioxide production, 10% of global methane production, 7% of global particulate matter production and 39% of organic carbon particulate production.⁹² It affects the reflectivity and emissivity of the Earth's surface as well as the hydrological cycle by changing rates of land evaporation and water runoff. For these reasons, biomass burning is a significant driver of global climate change.

Toxic Chemicals

Although LEED™ addresses the use of toxic substances only with respect to indoor air quality (IAQ), the life cycle analysis approach includes the toxic releases associated with *all* phases of a material's life cycle, not just the use phase. From this perspective, toxics fall within the context of LEED™ *Materials & Resources*.

The simplest synonym for a toxic is a poison, something capable of causing injury or death, especially by chemical means. Toxic emissions to air, land, and water include compounds such as pesticides, heavy metals, petroleum

products, and by-products of industrial activities. In certain environments, these compounds can be acutely toxic or can cause chronic or sublethal effects; they also can bioaccumulate in food chains.

Estuarine food chains are extremely complex and sensitive to alterations in the physical and chemical range of stresses. Loss or disruption of one element can have a cascading effect on species' presence and productivity. As with any form of pollution, there are variable impacts depending on the nature of the chemical (e.g., its persistence in the environment) such that the adage 'the dose is the poison' may not accurately represent short and long term impacts.

According to "Nonfishing Activities Affecting Salmon Habitat", a properly functioning habitat can accommodate low levels of chemical contamination and no excess nutrients. A habitat is considered "at risk" when there are moderate levels of chemical contamination and some excess nutrients. A habitat is "not properly functioning" when there are high levels of chemical contamination and excess nutrients.⁹³

Both the Puget Sound and the Duwamish Waterway are salmon habitats impacted by toxic chemicals, with the chum, coho and chinook the predominate salmon species passing through the Puget Sound estuaries as they move from fresh to salt water. While only living in the estuarine environment for part of their life cycle, studies document that the contamination in those environments adversely affects salmon health. Research concentrates primarily on juvenile chinook salmon because they most depend on estuaries for their food, stay there the longest of the three species, are representative of all five salmon species in the juvenile stage, and experience rapid physiological change and growth which potentially increases their vulnerability to chemical pollution.

In the April 2001 EPA Fact Sheet, "Update: National Listing of Fish and Wildlife Advisories," the Puget Sound is

listed as one of the 20 National Estuary Program (NEP) sites, and as one of the 14 National Estuarine Research Reserve Systems (NERRS) sites. According to this fact sheet, in 2000 there was a general fish consumption advisory for Puget Sound due to PCBs, dioxins, and mercury, while specific Puget Sound embayments were subject to advisories for the following pollutants: creosote, pentachlorophenol, volatile organic compounds (VOCs), tetrachloroethylene, arsenic, metals (unspecified), vinyl chloride, polyaromatic hydrocarbons (PAHs), polynuclear aromatics, and pesticides (unspecified).

Based on studies conducted by the National Oceanic and Atmospheric Administration's Environmental Conservation Division (ECD), diet is the salmon's primary source of exposure to toxic contaminants. In the study, researchers found significantly higher levels of aromatic hydrocarbons (AHs) and PCBs in the stomach of salmon that passed through an urban estuary (Duwamish Waterway) vs. those that passed through a non-urban reference site (Nisqually River).⁹⁴ These data corroborate findings from an earlier study undertaken by the National Marine Fisheries Service which also found elevated levels of AHs and PCBs in salmon migrating through the heavily polluted Duwamish and Puyallup waterways than from other sites. Moreover, these salmon were found to have heightened levels of an enzyme activity that results in toxins binding to DNA, thought to be an early stage of carcinogenesis.⁹⁵

Persistent Bioaccumulative Toxins

The pollutants referenced in the aforementioned Puget Sound fish advisory, PCBs, dioxins, and mercury, are all *persistent bioaccumulative toxins* (PBTs),⁹⁶ a class of chemicals gaining increased recognition. These chemicals build up in salmon as well as humans - species positioned near the top of their respective food chains - increasing the incidence of effects such as chemical modification of DNA and alteration of

immune functions. As numerous recent public policy initiatives indicate, PBT phase-out and elimination is increasingly being viewed as fundamental to achieve environmental and human health. Indeed, on 1 July 2002 the Seattle City Council passed a resolution to reduce the City's purchase and use of products that contain persistent bioaccumulative toxics, or that result in the release of PBTs during their manufacture (such as PVC). See sidebar for a description of PBTs.

Building related industries that release discharges into the Duwamish Waterway, characterized by some as the most polluted estuary in Puget Sound, include cement processors and municipal sewage treatment plants.⁹⁸ However, this finding contradicts the BaselineGreenTM analysis that found direct building-related releases to water only from three wood treatment facilities, one in Pierce County and two in Clark County. This finding is also not corroborated by conversations with officials at both plants who claim no direct releases to surface waters, although they do release to the municipal wastewater utility. While as of this writing neither Seattle cement kiln burns hazardous waste as a fuel source, both burn tires and other wastes that could emit PBTs.

Determining the risk to salmon associated with PBTs is important to establish. In a paper presented at the 1999 American Fisheries Society Forum on Contaminants in Fish, "Tribal Technical Issues in Risk Reduction Through Fish Advisories"⁹⁹ the authors address risk characterization, and offer several equations to guide decisions concerning risks to specific fish populations. For example, the equation "risk = exposure x toxicity x sensitivity" provides flexibility to acknowledge the unique sensitivities of particular populations (species) to specific chemicals. Another equation is designed to capture the cascading effects between human health, ecological health,

Persistent Bioaccumulative Toxins Brief Description

"These chemical contaminants accumulate in the tissues of aquatic organisms at concentrations many times higher than concentrations in the water. These chemical contaminants also persist for relatively long periods in sediments where bottom-dwelling animals can accumulate and pass them up the food chain to fish... Concentrations of these contaminants in the tissues of aquatic organisms may increase at each level of the food chain. As a result, top predators in a food chain...may have concentrations of these chemicals in their tissues that may be a million times higher than the concentrations in the water. Mercury, PCBs, chlordane, dioxins, and DDT...were at least partly responsible for 99% of all fish consumption advisories in effect in 2000."⁹⁷

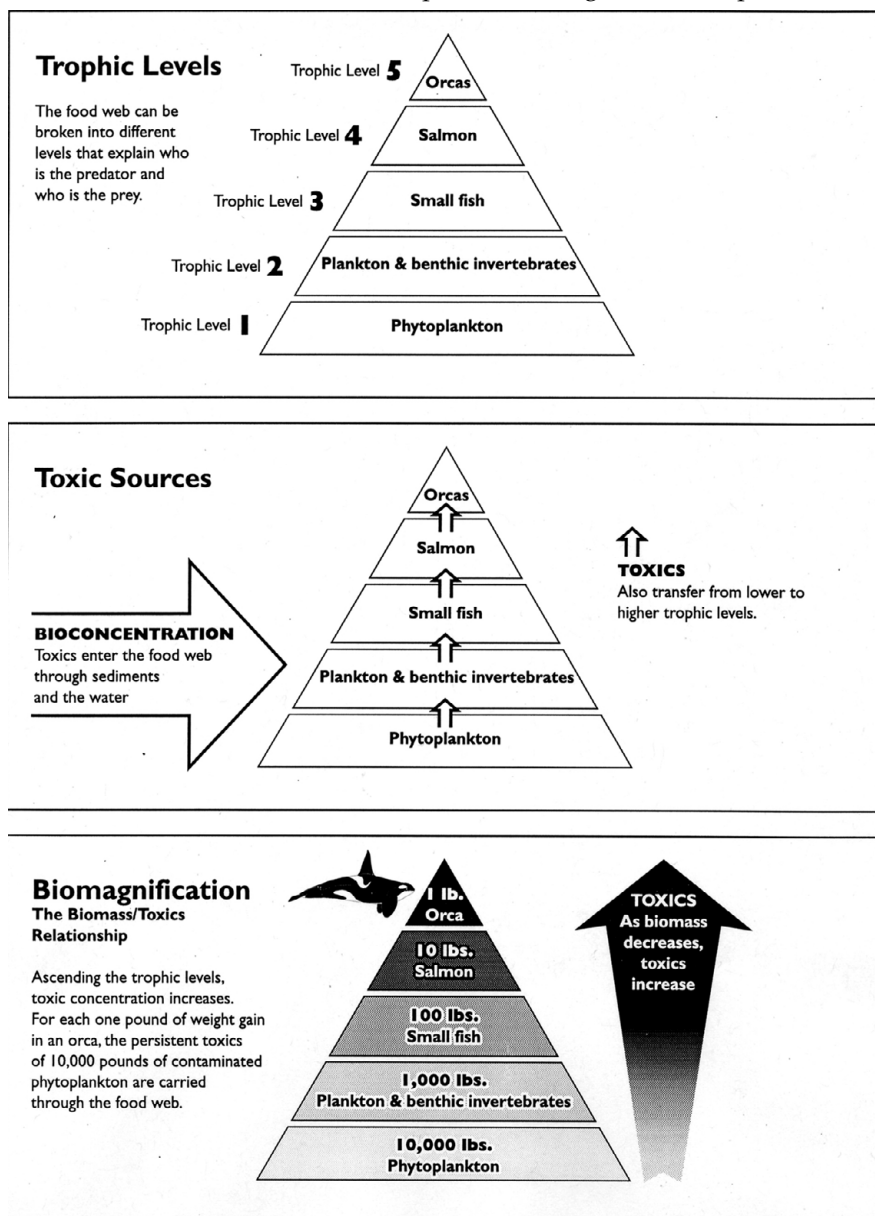
ecological injury, economic impacts and cultural impairment: "health risk to an individual = health effects + $a(\text{ecological risk}) + b(\text{economic risk}) + c(\text{cultural risk})$." They do not accept temporal discounting, instead positing that "...risk must be summed for as long as the material remains intrinsically hazardous, remains in the environment, or for as long as the impact (including mutations) persist in the

population."¹⁰⁰ Thus, while not explicitly referencing persistent bioaccumulative toxins, they implicitly acknowledge the necessity to address them as a class of chemicals requiring special accommodation, as is underway with Washington State's PBT initiative. It is also important to note that the paper addresses uncertainty, and identifies the Precautionary Principle as a decision-making approach to be used when there is uncertainty and as a complement to risk assessment. (See Precautionary Principle sidebar above)

Reflecting their persistence, bioaccumulation, and toxicity, the federal government and many state governments, including Washington and the City of Seattle (as previously mentioned), have launched policies and programs intended to result in the elimination and phase-out of human-induced PBTs in the environment. This prioritization of PBTs amongst domestic policymakers at the local, state and national scales underscores the importance of these initiatives. While there are differences in the individual PBT chemical lists developed by varying regulatory and environmental organizations, there is consistency with some chemicals on each list. (The December 2001 Washington Department of Ecology's "Washington PBT Working List: Summary Report" identifies 25 priority chemicals and chemical groups.) Among the consistently identified PBTs are cadmium, dioxins and furans, lead, and mercury, each of which have correlation to specific building materials and products manufactured today. (Another priority PBT chemical, PCB, has been phased out though it persists in the environment.) See Table 10 for a list of PBTs commonly associated with building materials.

The State of Washington recently authorized \$800,000 towards a PBT strategy designed to eliminate PBTs from the State, with a priority on pesticides (Aldrin/Dieldrin, Chlordane, DDT, Toxaphene), by-products (benzo(a)pyrene, dioxins and furans, PCBs), hexachloro-benzene, and

Figure 7: PBTs in the Food Chain



Source: "Toxics in the Food Web," People for Puget Sound.
www.pugetsound.org/toxicfoodweb/default.html

mercury, with dioxins, furans, and mercury having specific links to building materials. In their most recent PBT listing, Washington State identified mercury as the priority PBT chemical. Buildings potentially contribute to upstream, use, and downstream life cycle phase mercury releases through the use of fluorescent bulbs (both tubes & compact fluorescents), high intensity discharge (HID) lamps, paint and electrical switches. Reflecting a recent ruling from the Washington State Department of Ecology, fluorescent lamps are generally considered a “Universal Waste” and require disposition at a lamp recycler or permitted hazardous waste disposal company. Although crushed lamps are allowed at many recycling operations, keeping lamps intact helps to ensure that the mercury is contained until properly processed at a recovery or disposal facility. Just as important, procurement of fluorescent bulbs should specify lowest available mercury; indeed, several manufacturers are diversifying their product lines to offer low-mercury bulbs reflecting concern about mercury’s toxicity. Such stringent recycling and procurement policies are especially important as fluorescent bulbs are gaining greater market share, particularly with increased percentages in the residential market due to their long bulb life and reduced energy consumption.

The City of Seattle will be providing specific guidance for its residential customers regarding appropriate disposition of compact fluorescent bulbs, encouraging them to deposit the bulbs at a free Household Hazardous Waste site.¹⁰¹ More information is available at 206/296-4692.

Seattle City Council’s passage in 2002 of a Persistent Bioaccumulative Toxics resolution acknowledges the importance of establishing comprehensive procurement and disposal policies to ensure that mercury does not enter the waste stream or is accidentally released. It is important to note, as well, that all manufacturers of fluorescent bulbs have not actually reduced the actual quantity of mercury in their bulbs but

instead have added materials to their bulbs to reduce the amount of leaching. Other potential sources of mercury releases are thermostats and switches. For new purchases, specify mercury-free thermostats and switches (note that Oregon has instituted a ban on mercury thermostat installation) and, prior to building demolition or renovation, ensure that HVAC systems are assessed for mercury containing switches and thermostats and divert these from the construction/demolition waste stream to an appropriate recycling facility.

In 1993 U.S. EPA researchers began studying the effects of dioxins, specifically 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), on aquatic life, and determined exposure to be extremely damaging. While toxicity test results found that aquatic organisms’ exposure to TCDD was not toxic during acute test periods of 24 to 96 hours, studies found that the exposure results in delayed adverse effects in days, weeks and months following. However, there continues to be uncertainty as to the species’ sensitivity distribution within fish, and effects on reproduction associated with chronic exposure.¹⁰² Recent data indicate that the Ash Grove cement plant emitted .454 +206 grams /year of dioxin in 2000, while the Lafarge plant emitted about 2 grams/year,¹⁰³ with the difference in emissions reflecting the fuels burned in the respective plants.

Another PBT, dioxin, is released during the life cycle of polyvinyl chloride (PVC). According to a 2000 study by researcher Joe Thornton, Ph.D., PVC is responsible for more dioxin formation through its life cycle than any other single product, reflecting the high percentage of chlorine in its chemical composition. Seventy-five percent of PVC plastic is used in building-related applications such as piping, flooring, wallcoverings, roofing, and exterior siding.¹⁰⁴ While not manufactured in Washington State, PVC, like other products that release persistent

Table 10: Persistent Bioaccumulative Toxins (PBTs) Commonly Associated with Building Materials

Cadmium	used as a stabilizer in rigid polyvinyl chloride and paints
Dioxins & furans	emitted from cement kilns, secondary copper manufacture, & by-products of vinyl chloride monomer
Lead	used as a stabilizer in rigid polyvinyl chloride, and manufactured into roof flashing, & terne & copper roofing materials
Mercury	used in fluorescent light tubes, high intensity discharge (HID) lamps, paint, and electrical switches

Table 11: Distinguishing between harmful by-products of PVC¹⁰⁵

Persistence	substance resists natural degradation, builds up over time in the environment, and can be distributed globally on currents of wind and water. Many of the by-products of the PVC lifecycle are now ubiquitous global pollutants, found not only in industrialized regions but in the planet’s most remote ecosystems. Absolutely every species on Earth is now exposed to these substances.
Bioaccumulation	a substance is fat-soluble and therefore builds up in living tissues. Most bio-accumulative substances, including many formed during the PVC lifecycle, magnify as they move up the food chain, reaching concentrations in species high on the food chain millions of times greater than their levels in the ambient environment.
Toxicity	the by-products of the vinyl lifecycle have been shown to cause a range of health hazards, in some cases at extremely low doses. These include cancer, disruption of the endocrine system, reproductive impairment, impaired child development and birth defects, neuro-toxicity (damage to the brain or its function), and suppression of the immune system.

Table 12: 1999 Washington State Building-Related Industries Reported Toxic Releases to Water

Manu- facturer	Co.	Pro- duct	Chem- ical(s)	Tot. Rele- ases (lbs)
Cascade Pole & Lumber	Pierce	Treated Wood	Creosotes	10
Allweather Wood Treaters	Clark	Treated Wood	Chromium Compounds Arsenic Copper	12 10 7
Exterior Wood, Inc.	Clark	Treated Wood	Chromium Compounds Arsenic Copper Compounds	12 12 7

bioaccumulative toxics (PBTs) during some stage of their life cycle, could be a trigger for altering the chemistry of salmon. This phenomenon reflects the three qualities that define PBTs – *persistence, bioaccumulative, and toxic*. According to the Global Network of Environment and Technology, “PBT pollutants pose regulatory and environmental challenges because they easily move between air, water, and land, and cross boundaries of programs, geography, and generations.”¹⁰⁶ Thornton’s study identifies the by-products of the vinyl lifecycle to be of great concern because many of their components are persistent, bioaccumulative, and toxic. (See Table 11)

Lead is another persistent bioaccumulative toxin of concern. Although it has been largely eliminated from paint products and gasoline sold in the U.S., lead continues to be used in roofing applications, including in terne roofing and, more commonly, as roof flashing. While little attention has been directed to its elimination in building materials in the U.S., beginning in December 2002 Denmark will ban the use of lead flashing in new buildings, citing studies that “...have proved that lead leaching from building flashings is the chief source of lead in wastewater and wastewater sludge.”¹⁰⁷

Acknowledging the significant deleterious impacts of PBTs on public and environmental health, governments have begun to establish policies and programs to transition towards PBT elimination. A June 28, 2000 letter from former Seattle Mayor Paul Schell encouraged Washington Department of Ecology’s adoption of a “strong (PBT) strategy and to direct the necessary resources toward its implementation.” Schell further noted, “The persistent and bioaccumulative nature of these chemicals requires aggressive steps to protect Washington’s environment for this and future generations...”.

BaselineGreen™ Results

In this section, we summarize findings of the BaselineGreen™ analysis which focuses on the upstream portion of the life cycle of building materials, recognizing that what happens in the course of extracting, manufacturing, and transporting building materials can impact salmon. The full BaselineGreen™ report is in Appendix A.

Earlier in this report, upstream building-related environmental burdens affecting salmon habitat were prioritized from most direct to least direct impact:

Most direct:

- Toxic releases to water,
- Toxic releases to land/
underground,
- Toxic releases to air,
- Criteria air pollutants,

Least direct:

- Greenhouse gas emissions.

For each of these five emissions, the BaselineGreen™ analysis yielded these findings:

- **Toxic releases to water:** Compared to other industries such as paper manufacturing, building-related industrial toxic releases to water reported in 1999 were relatively small. This is true for both the tri-county region and the rest of the State of Washington, for which there was a reported total of 70 pounds of toxic releases to water from three wood treatment facilities. The single facility in the tri-county region discharged 10 pounds of creosotes to water, while two other facilities in Clark County discharged 60 pounds of chromium compounds, arsenic, and copper compounds (the primary constituents in CCA-treated wood, now slated for a U.S. EPA promulgated phase-out by December 2003). These reported toxic releases to water are in addition to unreported toxic releases to water at the same facility, resulting from

polluted stormwater run-off contaminated by treated wood stored on an unprotected outside site.¹⁰⁸ To put this in perspective of total industry toxic releases to water, a single paper manufacturing facility in the tri-county region released over 500,000 pounds of toxic chemicals to water in 1999. (See Table 12)

- **Toxic releases to land:** With the exception of waste disposal, building related industrial toxic releases to land reported in 1999 were zero. This is true for both the tri-county region and the rest of the State of Washington.

- **Toxic releases to air:** Compared to other industries, building related industrial toxic releases to air in 1999 were relatively small. The percentage of statewide reported toxic releases to air that can be attributed to building related industries is less than 5% of the total. (See Table 13)

- **Criteria air pollutants:** With one exception – cement - building-related industrial criteria air pollutant releases in 1999 were relatively small. The cement industry accounts for a fairly large share of all types of criteria air pollutant emissions in the tri-county region.

- **Greenhouse gas emissions:** Emissions of CO₂ associated with the manufacture of cement (SIC code 3241) and fabricated steel products (SIC code 3441) account for a substantial portion of greenhouse gas emissions (GHGs) in the tri-county region and possibly a large portion of GHGs in the rest of the State of Washington. Two cement plants in the tri-county region account for approximately 1 million tons of CO₂ emissions per year. The CO₂ emission total for Birmingham Steel is about 53,000 tons per year.¹⁰⁹

In summary, the BaselineGreen™ analysis revealed a small quantity of *direct* links between upstream environmental

burdens associated with the manufacture of building materials and products and environmental factors detrimental to salmon habitat. For the most direct environmental burden, toxic releases to water, three building-related industries reported releases in 1999. For the second most direct burden, toxic releases to land, no building-related industries reported releases in 1999.

It appears that, as the links between upstream environmental burdens and salmon habitat become more *indirect*, the role of building-related industries becomes more significant. Several building

Table 13: 1999 Tri-County Building-Related Industries Reported Toxic Releases to Air

Manufacturer	County	Product	Chemical(s)	Total Releases (in pounds)
American Millwork	King	Millwork	Toluene Methyl ethyl ketone Methyl isobutyl ketone	154,000 146,000 59,000
Girard Custom Coaters	Pierce	Lumber & Wood products	Toluene	72,681
Newcastle Brick Plant	King	Brick & Structural Clay Tile	Hydrofluoric acid	52,110
Johns Manville Intl	King	Plastic Foam	1,1-Dichloro-1-fluoroethane (an ozone depleting compound) Chlorodifluoromethane Diisocyanates	39,243 4,724 49
Tiz's Door Sales	Snohomish	Millwork	Toluene	28,748
Lianga Pacific Inc.	Pierce	Millwork	Xylene	11,630
Northlake Cabinet Corp.	King	Wood kitchen cabinets	Toluene	11,179
Canyon Creek Cabinets	Snohomish	Wood kitchen cabinets	Methanol	10,973
Cascade Pole & Lumber Co.	Pierce	Wood preserving	Creosote	1,805
Birmingham Steel	King	Steel	Zinc compounds Manganese compounds Lead compounds Nickel compounds	21,827 2,201 1,646 17
Haworth/Lunstead Ops.	King	Wood Office Furniture	Methanol Toluene	11,947 12,200

related industries reported toxic releases to air, for example. However, the building industry share of annual releases is relatively small as compared to other industries, accounting for only about 5% of total toxic air releases in 1999.

Similarly, for criteria air pollutants, several building-related industries reported emissions, but the total was relatively small compared to other industries. The one exception in the tri-county region is the cement industry, which accounts for a large share of local air pollutants.

As mentioned earlier, the impact of criteria air pollutants on salmon habitat is indirect. The pollutants must return to land and water via atmospheric deposition. Airshed patterns and monitoring of several sites in western Washington indicate that the area is not susceptible to atmospheric deposition. Additionally, air pollution associated with a building may be much greater during its “use” stage due to energy consumption over a building’s lifetime.

Similarly, for criteria air pollutants, several building-related industries reported emissions, but the total was relatively small compared to other industries. The one exception in the tri-county region is the cement industry, which accounts for a relatively large share of local air pollutants.

Related to global climate change, also an indirect factor affecting salmon habitat, the effect of upstream building-related industrial greenhouse gas emissions is similar to that of air pollutants. Again the one exception is the cement industry which likely accounts for a relatively large share of local upstream greenhouse gas (GHGs) emissions. Upstream GHGs, however, are relatively small compared to energy consumption during the use stage (occupancy) of a building over its lifetime and to other sources of GHGs (e.g., the transportation sector).

There are, however, several caveats that should be acknowledged qualifying the above findings:

- The Toxic Release Inventory (TRI) data used for BaselineGreen™ relies on industry-generated reports. It is possible that some releases may be unreported or under-reported;
- Establishing direct cause-effect links between specific stressors and salmon is difficult. Scores of studies and scientific reports reference uncertainties associated with definitive declarations of what are contributing factors to salmon decline;
- The qualitative dimension of persistent bioaccumulative toxins (PBTs) as a class of chemicals may not be adequately represented by the way toxic release data are currently reported. Because toxic releases are only reported by quantity, the reporting may not reveal the degree of toxicity associated with small quantities of some chemicals. Beginning in the reporting year 2000, the U.S. EPA has added dioxin and other persistent bioaccumulative toxins to its TRI list of chemicals, with lowered reporting thresholds for certain PBT chemicals. Most PBT chemicals will be reportable at thresholds of ten pounds or 100 pounds manufactured, processed, or otherwise used.

While there are only a few building-related industries reporting toxic releases to water, there are releases to air of both greenhouse gases (principally CO₂) and toxic chemicals. Both of these may result in indirect impacts on salmon: in the case of CO₂ releases, the consequent climate change is associated with rising global temperatures; in the case of toxic releases to air, these chemicals disperse and may eventually fall to the ground, impacting land and water quality. Because of the more distributive nature of air releases than water releases, the point source relative to proximity to habitat is of diminished importance, particularly when these releases are PBTs.

These results point to other possible building-related activities as having a more significant impact on salmon habitats in the region, several of which are detailed elsewhere in this report, and below.

Upstream in the life cycle of buildings, impacts from resource extraction, such as erosion and sedimentation from logging and mining, can be substantial. BaselineGreen™ is not structured to inventory and map regional erosion and sedimentation related to upstream building activities. Additionally, there are supply chain activities that may have environmental impacts other than the three environmental burden indicators mentioned above. Besides erosion and sedimentation, those impacts include loss of vegetation, other changes in land cover, and fertilizer, pesticide, and herbicide use.

A prime example of this is the stormwater release from Cascade Pole & Lumber, located in Tacoma, a facility that treats poles, lumber, and decking. Because the treated wood products are stored in an unprotected outdoor yard, storm events will likely result in the discharge of arsenic, chromium, copper, and pentachlorophenol (penta) into the Puyallup River, host to three runs of chinook salmon listed in the Endangered Species Act, as well as one run of listed bull trout.¹¹⁰ Penta, a powerful insecticide and a PBT, is often contaminated with dioxin, and has been banned in 26 countries including Germany, Egypt, India, Indonesia, and Korea. Since this industrial pollution is associated with stormwater rather than a continuous discharge, it does not show up in the BaselineGreen™ analysis. And, because this toxic release to water comes from runoff, it also could be classified as a release to land.

Given these conclusions, the following recommendations are made as salmon-friendly policies and practices. These recommendations follow the format outlined in LEED™ 2.0 “Materials and Resources.” However, because the BaselineGreen™ methodology is based on

a life cycle assessment (LCA) approach to assessing environmental impacts, in some cases the recommended practices are different than LEED™. These differences will be discussed under the appropriate LEED™ Credits below.

Salmon-Friendly LEED™ Overlay for *Materials and Resources*

Prerequisite 1: Storage and Collection of Recyclables

RECOMMENDED ACTION:

- Ensure that mercury-containing bulbs are properly stored to prevent breakage and potential for release of mercury.

Credit 1: Building Reuse

RECOMMENDED ACTION:

- Maximize reuse of major portions of existing buildings, such as the structure and shell.

Reusing large portions of existing structures reduces the need for newly manufactured building materials and products. As described in the three BaselineGreen™ analyses reviewed in this report, every manufactured building material and product is associated with some form of upstream environmental burden. Reusing major portions of existing buildings, such as the structure or shell, can minimize or even avoid some of these burdens.

Credit 2: Construction Waste Management

RECOMMENDED ACTION:

- Recover and recycle construction and demolition debris.

Recovering construction and demolition debris and recycling it into new products can lessen the environmental burdens associated with manufacturing with virgin materials, particularly when the materials are recycled in the region.

Credit 3: Resource Reuse

RECOMMENDED ACTION:

- Maximize reuse of salvaged or refurbished materials and products from existing buildings.
- Maximize use of industrial byproducts like fly ash.

Specifying salvaged or refurbished materials can reduce the need for newly manufactured building materials and products. Similar to building reuse, using recovered materials and products from existing buildings, such as beams, columns, flooring, doors, and windows can lessen or even avoid upstream environmental burdens.

An LCA approach to assessing environmental burdens reveals that many industrial processes produce usable byproducts that are not technically post-industrial or post-consumer recyclables. They are used as processing agents or are physically different than the material or product being manufactured. Unlike recycled or scrap materials, many byproducts do not require further processing before being used in the manufacture of another material or product. Fly ash and slag are examples. Under the topic *Resource Reuse* therefore, BaselineGreen™ recommends the inclusion of by-product materials.

Credit 4: Recycled Content

RECOMMENDED ACTION:

- Substitute recycled content materials and products for processed virgin materials.

Recycled content materials and products reduce negative environmental impacts associated with the extraction of new raw materials. Processing of virgin materials consumes both energy and resources and is usually associated with some form of upstream environmental burden. Processing with recycled content feedstocks

will eliminate impacts associated with raw material extraction, but may result in manufacturing-related emissions of concern. For example, as Table 13 (page 55) shows, Seattle's Birmingham Steel, a scrap-based steel mill, has air emissions including 1,646 pounds of lead compounds based on 1999 U.S. EPA Toxic Release Inventory data.¹¹¹

Recycled content substitutes for portland cement relieve the significant CO₂ emissions associated with the manufacture of portland cement. High volume coal-derived fly ash concrete mixes should be evaluated for efficacy (both cost and performance) for all concrete applications, with a provision to assess the chemical composition of the fly ash to ensure that it does not pose exposure risks to workers or building occupants. Although our research only confirmed indirect impacts to salmon habitat, cement manufacture is responsible for a huge portion of local and regional air pollution and greenhouse gas emission burdens. These burdens can be greatly reduced with cement substitutes.

Other major products to examine under this credit are structural and fabricated steel products. These input items consistently appear as high priorities in terms of upstream environmental burdens for average U.S. construction of all three building types examined in this report, and are responsible for a large portion of local and regional air pollution and greenhouse gas emission burdens. In general, steel manufactured in electric arc furnaces (EAFs), such as with Birmingham Steel, are scrap-based manufacturers using primarily post-consumer feedstock such as cars as the feedstock. As indicated above, although there is a presumption that using recycled content feedstocks benefits the quantitative and qualitative burdens of emissions, further control enhancements are in order as even the EAFs are responsible for significant environmental releases.

As in *Resource Reuse*, above, an LCA approach to assessing environmental burdens reveals that many industrial

processes produce usable by-products that are not technically post-industrial or post-consumer recyclables. They are used as processing agents or are physically different than the material or product being manufactured. Fly ash and slag are examples. Under the topic "recycled content materials and products" therefore, the BaselineGreen™ analysis supports the inclusion of by-product materials.

Cement

RECOMMENDED ACTION:

- Evaluate converting the Lafarge plant to a dry process
- Evaluate converting both plants to natural gas, a cleaner burning fuel resulting in decreased emissions, some of which are considered harmful to salmon
- Prohibit burning tire-derived and other chlorinated fuels in cement kilns.
- Accelerate use of fly ash as a replacement for portland cement in all concrete applications.

Fly ash is a byproduct of coal fired power plants and as such is characterized as a post-industrial recycled material. All fly ash has pozzolanic properties, while Class C fly ash has both pozzolanic and cementitious properties. Substituting fly ash for portland cement in concrete mixes yields several benefits. We recommend the minimum percentage replacement of portland cement with Class F fly ash (available in the Seattle market) based on input provided by the Seattle firm Mithun Architects + Designers + Planners as below:

- Post-tensioned concrete – 25%
- Raft slabs, slabs on grade and architectural concrete – 40%
- All other concrete – 50%

A high volume fly ash concrete mix will

not only contribute toward achieving the LEED™ credit for recycled content, but will also diminish the embodied energy of the concrete and reduce its global warming potential.

Sand and Gravel

RECOMMENDED ACTION:

- Substitute industrial byproducts from regional industries for virgin gravel.

Alternatives to gravel, such as industrial byproducts from regional industries (e.g., aluminum smelters, coal-fired power plant), and crushed and graded post-consumer glass, should be considered to alleviate demand on local virgin resources. Additionally, according to Washington Department of Natural Resources' scientists, crushed quarry rock is environmentally advantageous to gravel since more rock is produced from quarries for the surface disturbance and quarries can be located away from flood plains and aquifers. The reduced disruption occurs because most quarries contain 100 percent usable rock, vs. gravel deposits with high porosity (less material per volume) and fines that do not have economic value.¹¹²

Washington Aggregate & Concrete Association's Bruce Chatkin acknowledges the use of recycled aggregates in concrete design mixes, and of crushed glass used for utility trenches, but indicated that the costs associated with processing and grading recycled aggregates makes them prohibitive in many applications.¹¹³ Seattle and other jurisdictions in the tri-county region should investigate strategies to lower costs to maximize the offset to virgin mineral stocks.

Credit 5: Local/Regional Materials

RECOMMENDED ACTION:

- Specify materials manufactured and sourced within 500 miles of the construction site.
- Compare LEED and BaselineGreen methodologies before specifying a material based on its location of extraction and manufacture.

Since this LEED™ credit calls for materials to be manufactured and sourced within 500 miles of the construction site, its scope is the entire State of Washington, and into Oregon and Canada.

LEED™ and BaselineGreen™ differ in their approaches to and recommendations for this topic. LEED™ recommends using local and regional products "across the board" as a means of reducing upstream environmental impact associated with the transport of goods and materials. However, an LCA approach reveals that there may exist much more harmful upstream burdens during the *extraction and manufacturing* stages of a material or product than during the *transport* stage. One should not assume outright that local and regional manufacturers have zero environmental burdens associated with their facility. In fact, the BaselineGreen™ analysis of average construction in the U.S. has informed us to initially assume otherwise. Thus, using local and regional materials is recommended only if an LCA approach is incorporated into the specification process.

Although the three BaselineGreen™ analyses indicated that, for average construction in the entire U.S., many building-related materials and products are associated with upstream toxic releases, air pollution, and greenhouse gas emissions, a review of the data suggests that local and regional industries in Seattle and the State of Washington are "cleaner and greener" than the U.S. average. In 1999, there were relatively small documented toxic releases to water, no toxic releases to land from local

and statewide building-related industries, and toxic releases to air attributed to building-related industries were less than 5% of the statewide total. Therefore, specifying materials and products from local and/or regional manufacturers will not necessarily result in an increase in associated upstream environmental burdens at the local and regional scale. With the exception of cement and fabricated steel products, the same can be said for upstream air pollutant and greenhouse gas emissions.

However, the above statement is made with caution. Many local and regional building related industries did report toxic releases to water, land, and air in previous years. Constant monitoring of upstream manufacturing impacts must be a part of any “buy local” program. The BaselineGreen™ analyses indicate that careful attention should be paid when specifying certain “high priority” building materials and products that consistently appear in average U.S. construction, though local and regional manufacturers were found to be “cleaner and greener.” (See sidebar)

Cement and steel have been discussed above under *Materials & Resources* Credit 4. Lumber is discussed below under *Materials & Resources* Credit 7. Although paint products are addressed in LEED™ 2.0 under *Indoor Environmental Quality*, that topic does not address the concerns raised by BaselineGreen™. The upstream impacts of paint manufacture are better addressed as a *Materials & Resources* topic. The recommendation regarding paints is to comply with standards for chemical content set by Green Seal third party certification guidelines.

Credit 6: Rapidly Renewable Material

RECOMMENDED ACTION:

- Specify straw-based products as wood substitutes.
- Step up efforts to establish straw-based manufacturing capacity in

Washington State.

Straw qualifies as a rapidly renewable material as its cycle from planting to harvesting falls within 10 years. As described above, Washington State is one of the nation’s largest wheat producers and, as such, has the potential to manufacture a variety of straw-based products to replace products manufactured from wood, such as particleboard and medium density fiberboard. No such manufacturing capacity currently exists in Washington State. We recommend specifying straw-based products as wood substitutes, and encourage current efforts to establish straw-based manufacturing capacity in Washington State.

Credit 7: Certified Wood

RECOMMENDED ACTION:

- All new wood-based products used in construction projects in the tri-county region should be from FSC certified sources when they are cost-competitive and equal or superior in performance than non-certified wood products.

As discussed above, rough and finish wood products consistently appear as “high priority” inputs in average U.S. construction. However, with the exception of criteria air pollutant emissions, local and regional manufacturers were found to be “cleaner and greener” than the U.S. average. Although only indirectly affecting salmon habitat, the processing of finished wood products such as millwork and plywood is responsible for a huge portion of local and regional air pollution and greenhouse gas emission burdens. Specifying products certified by an independent third party program is one step that can be taken to begin to minimize the environmental impact of wood product

Table 14: High Priority Inputs in Average U.S. Construction
<ul style="list-style-type: none">• Rough lumber products and processed lumber products such as plywood, waferboard, millwork, and wood cabinets (SIC codes 2421, 2426, 2431, 2436, 2491, 2493).• Cement (SIC code 3241).• Structural steel and fabricated steel products (SIC codes 3441, 3449).• Paints (SIC code 2851)

manufacturing in the region. Based on the discussion with Mr. Hrubes of Scientific Certification Systems, the authors recommend that all new wood-based products used in construction projects in the tri-county region be from FSC certified sources when they are cost-competitive and equal or superior in performance than non-certified wood products.

The Indoor Environmental Quality section of LEED™ has the least potential impact to salmon, even though it has a direct impact to human health, particularly from an indoor air quality point of view. It is interesting to note the similarities between the substances tracked by the U.S. EPA and included in BaselineGreen™ and those associated with poor indoor air quality. Both CO2 (a greenhouse gas) and VOCs (a criteria air pollutant) fall into both categories. LEED™ allows one credit for CO2 monitoring, and places limits on VOCs from adhesives, sealants, paints, coatings, carpet, and wood binders.

Impacts to Salmon

The same toxic chemicals used in the manufacture of paint, engineered wood products, carpet, adhesives, and sealants that impair indoor air quality can result in upstream releases during manufacturing, and downstream releases associated with disposal and recycling. This is especially problematic when the chemicals are persistent bioaccumulative toxins, as these can affect salmon even if their release is a far distance from the habitat.

Paint

Green Seal provides a basis to evaluate paints based on VOC emissions and chemical ingredients, while ensuring that the paints fulfill high-level performance requirements. Two paint manufacturers in the tri-county region reported toxic releases indicating the use of chemicals prohibited by Green Seal. However, a closer examination of these manufacturers reveal that some of their respective products comply with Green Seal requirements. A third paint manufacturer located in Seattle, Best Paints, manufactures non-toxic paints

with zero VOCs. However, a company representative did not disclose the chemical formulations; there were no reported toxic releases for Best Paints in the 1999 US EPA TRI reports.

While it is beyond the scope of this report to develop a toxicological analysis of these chemicals and salmon, our general point is that they may be contributing factors to salmon decline. In this regard, we recommend that a survey of best green chemical practices for paint manufacturers be undertaken to transition towards elimination of the targeted chemicals. Specifying locally manufactured paints that are Green Seal compliant would support the local economy and contribute to a healthier ecosystem.

Table 15: Paint manufacturers in the Seattle region and the areas of concern.

Company	Type of Product	VOC Level	Chemical Ingredients based on 1999 TRI Releases to Air
Farwest Paint Mfg. Co. 4522 S. 133 rd St. Riverton Heights, WA 98168	Household & industrial paints	Varying levels; some latex products are GreenSeal compliant; alkyd paints have VOC levels in excess of Green Seal allowable levels	Ethylene Glycol 3. Methyl Ethyl Ketone N-Butyl Alcohol Toluene Xylene (mixed isomers) Latex products do not appear to be manufactured with the prohibited ingredients; some of the alkyd paints are manufactured with Green Seal prohibited ingredients
Parker Paint Mfg. Co.	Household & industrial paints	Varying levels; Klean air interioreggshell, satin & semi-gloss, Prokote interior eggshell latex, Great Northwest interior flat and eggshell latex are GreenSeal compliant	Ethylene Glycol N-Butyl Alcohol 4. Toluene Xylene

Note: Chemical ingredients listed in **BOLD** print are on the list of Green Seal prohibited ingredients.

LEED 2.0™ provides for four innovation points to recognize design and construction practices that exceed established LEED™ levels and that introduce strategies not recognized in LEED™.

the energy savings accrued from fluorescent bulbs lessens other chemical emissions associated with fossil fuel-based electrical generation. PBT-free substitute materials and products are competitively priced and readily available for most building-related applications.

Materials & Resources

1. Chemically-Treated Wood: Because all toxic releases to water from building-related industries within the State of Washington are from lumber treatment facilities that use creosote, Copper Chromated Arsenic (CCA), and pentachlorophenol, look for opportunities to substitute treated wood with naturally-resistant FSC-certified wood or with recycled wood-plastic composite wood. Alternatively, specify wood treated with a less toxic chemical formulation, such as ACQ (Ammoniacal Copper Quaternary) or CBA (Copper Boron Azole). (A 2002 U.S. EPA ruling will ban the use of CCA treatment for most categories of wood use by the end of 2003.) The City of Seattle's Department of Parks and Recreation is taking appropriate action by only specifying non-arsenate pressure treated products, such as CBA and ACQ (as per Standard No. 06000.01, January 22, 2002.)

In addition, because the non-CCA treated wood processes use copper, which can be toxic to aquatic animals, ensure that all manufacturers cover the stored wood to eliminate stormwater contamination

2. Alternatives to PBTs: For products that release PBT chemicals at some phase of their life-cycle, such as with PVC, paint, roofing, portland cement, copper, substitute materials and products that do not release these chemicals. In the case of fluorescent light bulbs, specify only those that contain lowest available mercury, recognizing that



Conclusion



This section of the report highlights the primary impacts to salmon for all LEED™ categories, along with corresponding recommendations for the LEED™ salmon-friendly overlay. Recommendations for future work and further study will follow. The concluding remarks provide food for thought for reframing the problem of salmon decline.

Summary of Findings and Recommendations

In addition to summarizing the BaselineGreen™ results, five building related impacts to salmon are highlighted, along with corresponding salmon-friendly building strategies:

- stormwater runoff and impervious cover
- salmon-friendly hydro, greenhouse gas emissions and ozone depletion
- sand and gravel mining
- forest and agrifiber products
- toxic chemicals

BaselineGreen™

This life cycle-based analysis of building-related upstream impacts to salmon has shown that in the tri-county region and in the remainder of the State of Washington building related toxic releases to land and water were relatively small, while toxic releases to air were less than 5% of the statewide total. Except for cement, building-related criteria air pollutant releases were relatively small. Carbon dioxide (CO₂) emissions associated with the manufacture of cement and fabricated steel products account for a substantial portion of greenhouse gas emissions in the tri-county region and possibly in the remainder of the state. Thus the BaselineGreen™ analysis revealed relatively minor direct links – releases to water - between upstream environmental burdens associated with the manufacture of building materials and products and environmental factors detrimental to salmon habitat. Toxic releases to air, criteria air pollutants, and greenhouse gases associated with the manufacture of building materials are more substantial, but are also more indirect in their impacts to salmon. These somewhat surprising findings resulted in a more in-depth inquiry into other potential building-related impacts to salmon. The following five sections summarize the results of this research.

Stormwater Runoff and Impervious Cover

The authors acknowledge the substantial stormwater research efforts undertaken by the City of Seattle, other regional governmental and research entities, as well as by the State of Washington, and therefore direct specific inquiries to those bodies for analysis and recommendations as it is beyond the scope of this study.

Salmon-Friendly Hydro, Greenhouse Gas Emissions, & Ozone Depletion

Over 90% of Seattle's electricity is generated by hydropower facilities. As conventionally designed and operated, these are treacherous to salmon: dams can completely block the upstream migration of fish, even if equipped with fish ladders; reservoirs created by dams do not have the current needed to guide juvenile salmon to the ocean; dams

modulate flow such that they eliminate the spring freshets that hasten salmon to the sea, and at other times release so much water that it sweeps fish out of the river before they are ready, and washes away gravel and sediment; pumps and turbines in dams often suck up fish and kill them. The City of Seattle should be commended for its longstanding commitment to salmon-friendly hydropower, as evidenced in the successful implementation of the Skagit River Hydroelectric Project, and adherence to practices consistent with the Low Impact Hydro Institute.

Even with its heavy reliance on hydropower, greenhouse gas emissions in the form of CO₂ from building material related industries in the Seattle area are substantial. Greenhouse gases impact salmon through global warming which may diminish food supply in their ocean habitat, as well as adversely affect incubation and the timing and amount of flow volume in streams. The largest producers of CO₂ are the two cement kilns on the Duwamish Waterway which generate this greenhouse gas in the production process. Fly ash, a by-product from coal fired power plants, may be substituted for portland cement in concrete mixes. The authors recommend that the City of Seattle pursue the use of high volume fly ash mix concrete to reduce the net impact of concrete on salmon when it is cost-competitive and equal or superior in performance to conventional concrete design mixes. Increased exposure to ultraviolet (UV) radiation, as happens as a consequence of stratospheric ozone layer depletion, can threaten salmon vitality. Because their eggs or larvae lie in shallow waters during early spring, they are vulnerable to heightened UV levels. A review of tri-county manufacturers revealed that two reported use of CFCs in the last available TRI documents, although these chemicals were banned in 1996. Alternatives to ozone depleting compounds for manufacturing processes and as refrigerants and fire suppression chemicals should be accelerated beyond the phase-out dates stipulated by the Montreal Protocol, and, at a minimum, compliance with the phase-out schedule should be verified among all tri-county manufacturers.

Sand and Gravel Mining

Sand and gravel are the most common aggregates in concrete. Mining in general has degraded America's surface waters more than any other activity, and sand and gravel mining are particularly harmful to salmon. Wet pit gravel extraction directly and adversely affects spawning beds, causes sedimentation, changes stream morphology, alters channel hydraulics, and causes pollution in the form of hydrocarbons, heavy metals, and herbicides. Since Washington State has the fifth largest supply of aggregates in the United States, and sand and gravel represent the most valuable production commodity mined in the state, gravel mining operations are ubiquitous, representing over 9000 acres in the tri-county region. The authors recommend alternatives to gravel such as industrial by-products (e.g., aluminum smelters, coal-fired power plant), crushed and graded post-consumer glass, and crushed quarry rock, strict monitoring of all current sand and gravel extraction processes, and adoption of NMFS gravel policy for consideration of new and renewed permits. Policies for grandfathering of permitted facilities should be carefully reviewed to ensure that practices that could contribute to salmon decline are discontinued.

Forest and Agrifiber Products

Since forested lands are major producers of wood and salmon, forest management practices must take both into account. Timber management practices can cause profound changes in channel morphology, light, temperature and flow regimes. They can also change the abundance of large woody debris which provides critical salmon microhabitat in streams.

Logging roads can contribute to salmon decline through sedimentation delivered to streams through mass wasting and erosion. What's more, fertilizers and pesticides commonly used in forestry can be toxic to salmon directly if they enter surface waters, and indirectly by affecting the food available to salmon. Based on discussions with one of the certifiers for the Forest Stewardship Council (FSC) identifying the accrued benefits associated with FSC certified products, the authors recommend specifying FSC-certified wood products and materials when they are cost-competitive and provide equal or superior performance than non-FSC certified wood products and materials. In addition to choosing products that ensure greater protection to salmon than non-FSC certified sources, this action will help to bolster market demand, and potentially catalyze an increase in FSC-certified forests, recognizing that at present less than 2% of Washington State's forested lands are FSC-certified. Furthermore, to reduce the burden on forests, the authors also recommend increased use of agrifiber products, such as wheat straw board, and support the establishment of wheat straw-based manufacturing businesses in the State of Washington, such as has been begun by the Washington Department of Community, Trade and Economic Development

Toxic Chemicals

Toxic chemicals, particularly persistent bioaccumulative toxins (PBTs), are a serious threat to salmon, since they increase the incidence of chemical effects, such as modification of DNA, and alter immune functions. In 2000 the U.S. EPA issued a general fish consumption advisory for the Puget Sound due to contamination from several pollutants, including PBTs. Both the State of Washington and City of Seattle acknowledge the environmental health toll associated with continued release of PBTs and are launching initiatives to begin eliminating their procurement. Indeed, in a 1 July 2002 Resolution, the Seattle City Council passed a resolution, introduced by City Councilwoman Heidi Wills, to reduce the purchase and use of persistent bioaccumulative toxics, instructing the City to forego the purchase of products that contain persistent chemicals or that result in the release of persistent pollution during their manufacture. The PBTs cadmium, dioxin, lead, and mercury are all found in building materials. Cadmium is used as a stabilizer in polyvinyl chloride (PVC) and paints. Dioxins are emitted from cement kilns and as byproducts of vinyl chloride monomer processing and PVC combustion. Lead is also used as a stabilizer in PVC and to make roof flashing. Mercury is used in fluorescent light tubes, lamps, paint, and electrical switches. This resolution echoes our recommendation that the City of Seattle phase-out the use of PVC building materials, lead flashing and other lead roofing products as cost-competitive products of equal or better performance become available, specify paints that meet the Green Seal chemical requirements, and prohibit cement kilns from burning fuels that releases PBTs, and work with state and regional agencies to ensure the proper disposition of mercury containing light bulbs.

In addition, the authors note that the only reported toxic releases to water in the tri-county region originate from wood treatment facilities that use CCA, creosote, and pentachlorophenol chemicals. The U.S. EPA has banned the use of CCA for most wood applications by December 2003. However, despite the European Union's ban of creosote (scheduled for complete phase out by June 2003) due to heightened concerns of cancer risks, and, as of this writing, 26 countries that have banned pentachlorophenol*, both

** All uses prohibited by final regulatory action due to health or environmental hazards:*

Austria, Benin, Columbia, Costa Rica, Denmark, Dominican Republic, Egypt, Germany, Guatemala, Hong Kong, India, Indonesia, Italy, Jamaica, Korea, Liechtenstein, Luxembourg, Malaysia, Moldova, Netherlands, Nicaragua, Panama, Paraguay, Sweden, Taiwan, Yemen



chemicals continue to have permitted uses in the U.S. Because of the broad risks to public and environmental health, and particularly because of risks posed to salmon, alternatives to CCA, creosote and pentachlorophenol wood treatment chemicals should be specified as they are cost-competitive and equal or superior in performance in the tri-county region, with an effort to accelerate the EPA-sanctioned CCA phase-out prior to the December 2003 deadline.

Further Study

The authors suggest refinement and expansion of the proposed salmon-friendly building practices by connecting this effort on the part of the City of Seattle with two other Seattle-based organizations; Sustainable Seattle and the University of Washington.

Coordination with Sustainability Indicators

It is no surprise that many of the building related impacts to salmon previously highlighted in this study are already tracked as part of Sustainable Seattle's Indicators of Sustainable Community program.

It may be helpful to compare building-related historical data, such as number of permits issued, or housing starts, with these indicators to see if a correlation may be found. Of course, the most important correlation would pertain directly to wild salmon runs. But all of the other indicators have links to both salmon and buildings. Such correlations could then be used to prioritize and guide salmon-friendly building practice implementation. At a minimum, these indicators can be used to measure the effects of salmon-friendly building practice implementation.

Collaboration with Urban Ecology Simulation

We suggest a collaboration between the City of Seattle and the urban ecology modeling work underway by Dr. Marina Alberti at the University of Washington's Department of Urban Design and Planning to assess the impacts of building scenarios on salmon and stream quality. The preliminary findings of this research suggest that land cover change associated with urban development has adverse affects on stream quality. This work could overcome some of the shortfalls of BaselineGreen™ which is not structured to inventory and map regional erosion and sedimentation related to upstream building activities, such as logging and mining, nor to handle other supply chain activities that may have other environmental impacts, such as loss of vegetation, other changes in land cover, and fertilizer, pesticide, and herbicide use.

impacts, such as loss of vegetation, other changes in land cover, and fertilizer, pesticide, and herbicide use.

Concluding Remarks

This study has provided insights relative to enhancing the environmental health performance of buildings, particularly in ways advantageous to salmon, and applied them to the U.S. Green Building Council's LEED™ 2.0 rating system. Although this complies with the original purpose and scope of this study, adhering to these “salmon-friendly” building practices is not enough to reverse salmon decline in the Seattle area. The authors believe this to be true for several reasons:

First, other aspects of urbanization besides buildings, such as roads and other types of infrastructure, have substantial negative impact to salmon;

Second, regional industries not associated with the production of building materials, such as pulp and paper, have huge negative impacts to salmon.

Third, many of the measures in the salmon-friendly LEED™ overlay have to do with either mitigation or conservation, activities which will not necessarily address the root of the problem, but will lessen the impact of a problem which must necessarily be addressed as systemic.

The third reason, inspired in part by the work of William McDonough and Michael Braungart, is a bit unwieldy and has as much to do with how we *frame* this salmon problem as to how we *solve* it.¹¹⁴ Many of the recommended strategies have to do with eco-efficiency, using fewer resources and releasing less pollution. Yet addressing systemic problems requires systems thinking, and eco-efficiency does nothing to change the system. A good start on this tack would be to ask: how do we make the life cycle of a building truly a cycle? The simple answer is through development of an industrial ecology. The ultimate question may be: how do we not only lessen the impacts to salmon, but regenerate salmon, or perhaps provide the opportunity for salmon populations to regenerate themselves? There is no simple answer to this question, since it implies, among other outcomes, buildings that produce more or cleaner water than they consume, and that produce more power than they consume. More pointedly, we could ask: as a barometer of ecosystem health, what are the salmon telling us about the relationship between our industrial, constructional, and business practices as well as our lifestyle choices and living in balance with the natural systems upon which all life depends? As Chief Seattle said in his famous speech of 1854: “Man did not weave the web of life, he is merely a strand in it.”

Notes

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¹⁶ These deficiencies are to be addressed in future iterations of the BaselineGreen™ tool.

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